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Virtual Enterprise ←→ Virtual Integration

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The Rise Of The Virtual Enterprise -- As competition grows, companies are turning to virtual integration, which lets them concentrate on processes in which they can be world-class, and rely on someone else to perform the rest. (OUT OF THE BOX) (Internet/Web/Online Service Information) (Column)

Hammer, Michael

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ABSTRACT:
Fast-moving technology, increasing competition and the rise of the Internet are driving the creation of 'virtual enterprise' arrangements, which leverage the Internet for vertical integration and make use of business-to-business electronic transactions. Virtual enterprises are among the least publicized Internet applications, but may be the most important. The technology allows companies to focus on their core competencies while outsourcing others and retaining tight control over supplies, **contract** manufacturing processes and inventory. Cisco Systems is a well-known virtual enterprise, and whole industries such as the major automobile manufacturers are moving toward a **virtual business model**.

TEXT:

While Wall Street and the mainstream media have a boundless fascination with the Internet, they also seem unable to keep their attention focused on any aspect of it for more than a few weeks. Last year, business-to-consumer E-commerce was all the rage; now, business-to-business exchanges are a hot topic. Who can say what will come next?

All the while, one of the most important applications of the Internet is flying under the media's collective radar. The virtual enterprise (also known as virtual integration) is changing the entire concept of what it means to be a company.

In the early 20th century, Henry Ford's River Rouge plant achieved the height of vertical integration: in came iron ore and rubber, out came automobiles. Ford made his own steel, tires, and parts, then assembled them into cars. Although few other companies ever achieved this degree of self-sufficiency, the ideal of vertical integration underlay business strategy throughout the century. Companies wanted to control their own destiny and do everything for themselves; they only reluctantly used others as sources of parts or as a means of reaching their customers.

In today's hypercompetitive environment, however, companies can't afford to be second-rate at anything. Yet in an ever-more-complex world, it's impossible for any one company to be tops at everything. The solution in many cases is virtual integration-concentrate on processes at which you can be world-class, and rely on someone else to perform the rest.

Cisco Systems is one of the best-known virtual enterprises: Cisco concentrates on two essential processes-developing new products and selling products to customers-and leaves the rest to other companies. A **contract** manufacturer assembles the products from parts made by suppliers, and a materials-management company ensures the right amount of inventory is on hand, then delivers assembled products to customers. In most cases, Cisco never sees the products its customers receive.

In channel assembly, "manufacturers" don't actually make their products. The components are made by parts suppliers, and final assembly is done by distributors. The manufacturer designs the product and manages the distributor's parts inventory.

The major auto manufacturers are moving toward a model in which they will design the vehicle but not its individual parts; that will be left to parts suppliers. Some of the suppliers will also be responsible for assembling the vehicle's major subsystems (the interior, the chassis, and so on), which the manufacturer will combine at the end.

In all of these situations, it's difficult to determine where one company begins and another ends; the members of a virtual enterprise are tightly woven together. In a virtual enterprise, no single company can point to a final product and say, "We did that." Companies perform processes rather than produce complete products. When these processes all work together, the final product results.

Virtual **integration** goes far beyond **outsourcing** , in which a company lets others take care of nonessential functions. In a virtual enterprise, specialist firms perform critical processes-not because they're unimportant, but rather because they're so important that the original company can't afford to have them handled in a mediocre way.

The key to successful virtual integration is to enable all companies involved, each of which is performing only certain processes, to work together as smoothly as they would if they were all one enterprise. Enter the Internet. As a transport mechanism, the Net allows rapid, low-cost communication between businesses. Just as important, technologies that build on the Internet (such as the Extensible Markup Language) let the systems of all participants in a virtual enterprise mesh smoothly.

The implications of virtual integration dwarf those of E-commerce. As virtual integration spreads, companies will increasingly define themselves in terms of the processes they perform rather than the products or services they produce. The ability to integrate with others will become a vital core competence. New corporate cultures that value cooperation and sharing will emerge.

The virtual enterprise truly changes everything. The only question is: When will the mainstream media finally catch on?

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S2          0   VIRTUAL NEAR10 ALLIANCE??
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S12       606   AU=(HALE D? OR HALE, D?)
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19/9,K/2 (Item 2 from file: 15)
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Logistics and virtual integration Postponement, outsourcing and the flow of information

van Hoek, Remko I

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ABSTRACT: This paper uses empirical findings, from a survey and a case study, about the three (logistics) elements that constitute a virtually integrated supply chain: chain-wide application of postponement, extensive involvement of suppliers and distributors, and the integration of the flow of information. A virtually integrated supply chain differs from a traditional supply chain in that the flow of information is no longer a by-product of the flow of goods but makes an integral contribution to the creation of customer relations, services offered and cross-functional and cross-company interfaces. It was found that information communications technologies are critical in changing the supply chain format to become more responsive to individual customers, while involving multiple companies and functions. Challenges for the individual functions are formulated based on the findings from the two methods.

TEXT: Remko I. van Hoek: Erasmus University, Rotterdam, The Netherlands

Introduction

"Virtuality" seems to be developing in the international business world at a fast pace. A recent survey among members of a US Council of Logistics Management (CLM) roundtable revealed that logistics managers increasingly seem to focus their efforts on the development of information systems and software tools. This is leading to a new logistics practice or even a totally new business model. Dell computers, for example, has based much of its rapid growth and profits on being almost non-existent in the physical retailing sphere. Dell does not have stores or any other outlets, it does not make products and does not have inventories of finished goods. Instead, Dell sells directly to individual customers through the Internet and call centres. It buys modules and only does the final assembly of products when actual customer orders have been received; and it provides customers with customized products which are delivered directly within a number of days (postponed manufacturing). Michael Dell, founder of Dell Computers, calls this the **business model** of **virtual integration** (Magretta, 1998); the company is focused on the individual customer and integrates the supply chain through a linking up of the chain of information. Dell places far less attention on the vertical integration of the physical flow of goods.

The question can be raised as to what the move towards virtual integration implies for logistics, traditionally a function dealing with the physical flow of goods. How does one mange, structure and **control** logistics in virtual supply chains? Three elements of the logistics operating structure appear to be critical in the example of Dell computers:

- (1) the application of postponement throughout the entire chain (in purchasing, manufacturing and shipment);
- (2) the integration of the chain via information flow; and
- (3) the extensive degree of outsourcing and subcontracting.

Postponement is used to achieve customization and efficiency within one operating system. Integration of the flow of information is needed to achieve a seamless integration of functions and the large number of (outside) companies involved in the physical sphere. The company achieves **control** not through ownership, but rather by mastering the flow of information while focusing its competitive lead on the quality of its responsiveness to customers.

This paper aims to study both these elements and their role in the **virtual integration business model** . Two methods are used: a survey and a case study. A survey was developed and conducted among manufacturers to study the role of information and communication technologies in implementing postponement throughout the supply chain. To develop an understanding of the role of integration in the information flow, the supply chain of the SMART car (the new car developed by Mercedes and Swatch) is studied. This innovative product provides an example of how far-reaching the changes in the supply chain structure can be when companies target virtual integration and what the consequences of virtual integration (using postponement and information integration) are for logistics. The findings of the survey are used, in the final sections of the paper, to develop an overview of challenges for logistics and other operations in the virtually integrated supply chain, for the years to come.

Virtual integration

This section provides a short overview of the iterature on virtual integration/ ICT and logistics. A variety of books have been published about the coming of a new economic structure. General management books for example have projected the coming of an information economy or "the digital economy" (Tapscott, 1995) based on the growth of computing and information processing power. With the restructuring of the economy as a whole, business firms have to adjust to the new economics in the business world and it is projected that they need to develop new types of organization and strategy - "the virtual company" (Davidow and Malone, 1992). Part of these new economics is the increasing focus on knowledge development and distribution and using ICT and software to drive an "innovation explosion" (Quinn et al., 1997). It is projected that, given its ever-increasing availability, ICT will restructure transaction cost economics. In particular, external search, monitoring and distribution costs can be lowered so that transaction costs can be reduced significantly, favouring an increased focus on outsourcing, partnering and co-operation among various players (Bradley et al., 1993). This is seen as contributing to the creation of a virtually integrated supply chain in which integration and **control** is not based on direct ownership but rather on connectivity in the flow of information.

Authors have reflected on the specific potential of ICT for individual functions, such as marketing (e.g. McKenna, 1997), purchasing (e.g. Stank et al. (1997) and logistics. In particular, ICT is expected to make the flow of goods transparent (Bowersox and Daugherty, 1995), greatly facilitate the integrated management of physically separated units (La Londe and Powers, 1993), and permit decentralization and centralization to co-exist within individual operating systems. (Bowersox et al., 1992). Among other consequences ICT is expected to enable the application of postponement. Van Hoek et al. (1998) state that "it now is possible" to link the supply chain to individual customers and provide a customized product or service within a short timeframe, at acceptable costs.

Virtual integration and postponement

Postponement is the operating concept that aims at delaying activities until actual customer orders have been received and is used by companies to achieve customization costs hitherto associated with customization costs, such as set-up costs and the costs of storing finished goods. Bowersox and

Closs (1996) mention three types of postponement:

- (1) time postponement (involving the delaying of activities until orders are received in time);

- (2) place postponement (involving the delaying of moving goods downstream in the chain until orders are received, thus keeping goods centrally and not making them place specific); and
- (3) form postponement (involving the delaying of activities that determine the form and function of products until orders are received).

Zinn and Bowersox (1988) discuss the application of form postponement in assembly postponement, packaging postponement and labeling postponement. Feitzinger and Lee (1997) explain how Hewlett-Packard combines form postponement of final assembly with place postponement (inventories are centralized at a continental level) and time postponement (delaying shipment to customers until products are finalized based on orders).

The present paper develops the view that the generic types of postponement can be combined and used at multiple points in the chain simultaneously.

A central question is, what factors contribute to the implementation of postponement throughout the supply chain, or, in other words, which logistics operating contexts favour postponements. From Droge et al. (1995) and van Hoek et al. (1998) it can be expected that a strong relationship between information and communication technology and the application of postponement is a critical requirement. Van Hoek et al. (1998) state that ICT now makes it possible to implement postponement, and attribute inertia in the implementation of postponement over the past decades in part to inadequacies in technology. Indeed the postponement concept was introduced in the 1960s (e.g. Bucklin, 1965) but only recently received major managerial attention, coinciding with the ability of ICT to make the logistics chain transparent enough to make postponement feasible. Droge et al. (1995) state that the application of ICT externally (with suppliers and customers) and internally are critical in enabling postponement.

Based on the foregoing, it can be hypothesized that:

H1A:A positive relationship exists between the external application of ICT and the application of postponement.

H1B:A positive relationship exists between the internal application of ICT and the application of postponement.

Of course there are other contingencies relevant for the implementation of postponement, in particular in the market and the logistics operating environments. Clearly, markets should favour/require the application of postponement and the efficient customization of goods. Droge et al. (1995) point at the relevance of demanding markets in explaining the move towards postponement. For example as customer demands become less and less predictable the viability of postponement increases. When the volume and composition of demand is difficult to predict, obviously the relevance of delaying final manufacturing and shipment of goods increases. The variability of demand often leads to increasing product variety.on the one hand, whereas the unpredictability of demand cause inventory risks on the other. When all types of goods are stored in anticipation of possible orders, inventory levels and write-offs may be high, and service quality may even be poor. Finalizing and shipping products only when actual orders are received lowers the inventory of finished goods. When product parts have a high commonality (interchangeability between products) the semi-finished goods inventory can be significantly lower, in comparison to storing all different types of finished goods at sufficient levels to ensure accuracy in delivering finished products (see also Lee et al., 1993 and Zinn, 1990).

The competitive environment can be expected to impact generally on the relevance of postponement. Gilmore and Pine (1997) and Pine (1993) suggest that demanding markets have their impact on the entire competitive landscape, in that:

product life cycles are shortening because of the growing variability of demand and the growing need for customization;

production and product technology frequently has to change with new product life cycles; and

as competitor's actions are difficult to predict in fragmented and heterogeneous markets, marketing policies also frequently have to change.

Pine (19930 presents the changes in the competitive and market environment as a "reinforcing circle" leading to progressive increases in the competitive need for efficient customization. Combining standard modules into customer-specific finished products is mentioned as one of the most efficient options of achieving this required amount of customization by many authors (e.g. Kotha, 1995; Pine, 1993). It is therefore hypothesized that:

H2A:There is a positive relationship between the variability in demand and the application of postponement.

H2B:There is a positive relationship between the variability in demand and the application of postponement.

Apart from the market requirements, characteristics of the operating environment can also be expected to play an important role in the implementation of postponement. Expected inventory savings resulting from postponed final manufacturing were, for example, related to the commonality of components mentioned in formulating H2A and H2B. Cooper (1993) used operating characteristics in categorizing the viability of various postponement applications. Zinn and Bowersox (1988) studied the role of product volume and product variety in the viability of postponing final manufacturing activities. Zinn (1990) pointed at the role of the commonality of modules in the viability of postponement. Van Hoek (1998) argues that not only are the modularity of products and commonality of modules relevant, but also the complexity of the delayed manufacturing activities. Specifically, complex final manufacturing activities (i.e. involving complex combination of knowledge, capital and technology) may favour postponement; delaying these activities until customer orders are received avoids the risk of performing these expensive activities for products that will never be sold. Obsolete inventories are very expensive for these products and the re-working of products may be impractical.

Regarding volume and variety effects achieved in the final stages of the process, a negative relationship can be expected with the application of postponement. If, for instance, volume and variety increases are achieved through packaging and final assembly, inventory carrying costs and the required transportation space increase, thereby raising the cost of work in progress. If variety increases in these final stages of the chain inventory, costs increase because of the variety of products stored. If, in contrast, products and components can be stored in a generic and low voluminous form, by postponing final packaging or assembly, cost can be saved. When viewed in the context of the whole supply chain, however, the operational cost implications of postponed finalization may become less relevant. Postponement is not only relevant in the final stages of the chain but also can be applied in purchasing or components manufacturing.

Customization based on manufacturing activities such as the configuration or functionality of products or the adding of product features can be

expected to customize products more fundamentally.

In short, various operating characteristics should allow for postponement and it can be hypothesized that:

H3A:There is a positive relation between the complexity of final manufacturing and the application of postponement.

H3B:There is a positive relation between the modularity of the product and the application of postponement.

H3C:There is a negative relations between the volume and variety increase at the end of the chain and the application of postponement.

H3D:There is a positive relation between the use of manufacturing activities for customizing products and the application of postponement.

Method

Publications about postponement have used case studies (Feitzinger and Lee, 1997; Van Hoek et al., 1998) or analytical models (Lee et al., 1993; Zinn and Bowersox, 1988; Zinn, 1990). These publications have generated multiple insights into the relevance of various factors for the implementation of postponement. Statistical generalizations about existing practice, however, are rare. One of the few studies that did generate generalizations (Council of Logistics Management, 1995) was limited to an indication of the growth of postponement applications in recent years. In the survey, over 50 per cent of respondents from the USA and Europe indicated that they now used postponement more often than five years previously. The data did not indicate where in the supply chain postponement was applied, which factors influence the growth of postponement, or what benefits were experienced.

Our survey was developed to assess the importance of ICT, market and operating circumstances on the application of postponement throughout the entire supply chain. Ideas were drawn from previous studies and the questionnaire was pre-tested in 16 interviews with managers in the automotive supply, electronics, food and clothing industries. Of the 533 companies in these industries that received a mailed questionnaire, 80 responded (15 per cent) after one call-back and a second mailing. Companies were selected from a company database based on their status as manufacturers and involved in international markets (importing and exporting). International markets tend to favour postponement applications that go beyond packaging only (see cases in Cooper, 1993; Lee et al., 1993). The four industries were selected because of the likelihood of providing a balance between industries where postponement is extensively applied (electronics and automotive) and industries where it is less extensively applied (food and clothing). Pre-test interviews confirmed this balance.

Results

In order to assess the extent to which companies apply postponement, respondents were asked to specify, for various activities along the supply chain, the share of goods tailored to customer orders. Findings indicated that there are differences in the application along the chain. Downstream activities such as distribution and packaging are largely postponed (56.93 per cent of flow of goods and 53.95 per cent). Upstream activities such as engineering and purchasing are postponed to a lesser extent (37.49 per cent of the flow of goods and 37.42 per cent). Overall however, the findings indicate that postponement is applied at multiple points in the chain and to a significantly high share of the flow of goods.

Table I represents the items used in developing multi-item constructs that measure the factors identified in the hypothesis. Constructs contain a

minimum of two and a maximum of six items with a reliability of 0.67 minimum and 0.89 maximum. Postponement was measured throughout the supply chain, from engineering, through purchasing and manufacturing to distribution. Respondents were asked to specify the share of the goods flow on which these postponement applications are used The construct for postponement measures the application of postponement along the supply chain, from engineering and purchasing all the way down the chain to packaging and distribution. The other items were measured using seven-point Likert scales from 0 (not applicable at all) to 7 (very much applicable).

Figure 1 graphically displays the model which was developed using these constructs. The model uses the application of postponement as the dependent variable, because the objective is to explain the implementation of postponement according to the various factors that drive or facilitate its implementation.

The external application of ICT is operationalized using measures for upstream integration with suppliers and downstream integration with logistics service suppliers and customers. As hypothesized the construct was found to be related positively to the application of postponement. As expected, the implementation of postponement is facilitated when manufacturers are electronically linked to both customers and suppliers. A well-known example of how linking suppliers and the manufacturer to the customer can facilitate responsiveness if Benetton. This company uses point of sale scanner data in ordering products and in the planning of production and replenishment of goods in the store.

The internal usage of ICT is operationalized using a measure of ICT application between in-house functions and in-house production plants. Surprisingly, the internal application of ICT was found to be negatively related to the implementation of postponement. The negative relation suggests that manufacturers should concentrate on linking production externally (to customers) when preparing for postponement.

Two constructs were used to measure the market dynamics, one dealing with variability in demand and one for dealing with changes in competition and production. The first contains demand-related items and not surprisingly it was found to relate positively to the application of postponement. The need for responsiveness to dynamic markets is an important driver of postponement applications.

More surprising was the negative relation found between the second construct for the operating environment and the application of postponement. This construct contains production- and competition-related items. Apparently, these considerations disfavour postponement at present; this finding may indicate that product, production technology and marketing policies are not facilitating, or are not equipped for, postponement even though markets are demanding the application of postponement through the supply chain.

Relevant operational characteristics for the implementation of postponement are the complexity of final manufacturing (operationalized using measures for technological complexity, capital and knowledge intensity) and the modularity and commonality of the product design. As expected, they were both found to favour postponement. Less relevant for the implementation of postponement is the increase of product variety during the final manufacturing or packaging of products: as expected, this element of the operating characteristics was not found to be highly rated while the use of manufacturing activities (further upstream in the chain) for customizing products, was found to relate positively to the application of postponement.

Table II lists the correlation coefficients for the constructs and the significance of the relations. All individual relations are significant, as

well as the overall model (1 per cent level). Most importantly, the model explains 57 per cent of the variance, meaning that the application of postponement is explained in almost 60 per cent of all cases by the constructs used.

In connection with the findings that the production and marketing organization may not yet favour postponement, it was felt the SMART car provided an interesting example of a company attempting to prepare the operations in the supply chain for customization and extensive **outsourcing** , using information **integration** . The case presented in the next section may thus provide further insights into "how to make it happen".

The SMART car

Mercedes-Benz and SMH (Swatch) was expected to introduce a new vehicle concept, named SMART in late 1998. The car has been described as a new mobility concept aimed at reducing environmental damages caused by present traffic while satisfying individual mobility requirements. The conceptualisation goes beyond the actual car, and also embraces space saving parking concepts, networking with public transport systems and pool leasing. The car is a two-seater mini car (smaller than the Fiat 500), and has been developed mainly for in-city use. Both the car itself and the processes needed for producing and distributing the car to the final customer are focused on increasing the responsiveness to customer demands as much as possible. In general three stages in the supply chain are involved in achieving customization.

First, the generic car is assembled in the plant in Hambach in Elzas-Lothringen in France (referred to as SMART Ville). The car is based on an integral body-frame (called "Tridion") to which modules are attached/ assembled. The car consists of five main modules; the platform, the powertrain, the doors and roof, the electronics and the cockpit, containing sub-modules and components. The modules are supplied in sequence for final assembly by a small number of first tier suppliers of which seven are fully integrated into the final assembly plant. These seven companies are located at the same site as MCC and supply "super modules" based on a postponed purchasing approach. Modules are bought by the OEM only when they are needed in the final assembly process (postponed purchasing). For example a complete rear section, including wheels, suspension and engine, is pre-assembled by one supplier who maintains the module in its possession until it is needed on the assembly line. The same is true for the doors and for the dashboard system. Together these seven suppliers supply 50 per cent of the total value of the purchased product.

In order to enable a smooth flow of goods within the plant, the car is moved along the work stations of the assembly line, which has a lay-out in the form of a cross. In this way, the "integrated suppliers" are able to supply their finished products directly into the final assembly line from their workshop adjacent to the factory. The effect of this enlarged role for the "super module" suppliers is that MCC will be able to assemble the car in 4.5 hours. Apart from short lead-times the benefits of this product design and flexible manufacturing system are that at a module-level components can be combined into a wide variety of finished products.

Other activities, traditionally considered as the core activities of a car manufacturer, such as the pressing of body-parts and the painting process and even the co-ordination of internal logistics, will not be performed by MCC. Not only is there a close participation of the suppliers in the final assembly of the car, but the suppliers are also strongly involved in the development, planning and launching of the product. What can be said about the outsourcing of components and modules manufacturing is also true for supporting services such as transportation, the ownership and maintenance of the production buildings and general site management.

It is planned that the car will be sold at locations such as shopping centres and other highly frequented places in urban areas through franchised organizations. These will use multi-media systems to enable clients to "build" their car in the showroom and for forwarding the order for the car to the distribution centres. The customer can thus be involved in the design process and sales can become more consultative, based on a direct dialogue with individual customers. It is anticipated that five interregional distribution centres in Europe will supply the dealer with the requested car within an order-to-delivery lead time of less than one day. Some of the final assembling tasks, like adding special features or light final assembly will be performed at the distribution centres (i.e. postponed manufacturing). In order to perform final finishing, the distribution centre will store the appropriate components.

Finally, the modular concept of the car enables the customer completely to renew and upgrade the product during its lifetime, based on the addition of product-features and the rapid replacing of body-parts As a result the car will be more of a consumption product than a fixed capital good and can have an extendable life.

The challenges of virtual integration

The SMART case illustrates the application of postponement at multiple points in the supply chain, in this case involving extensive outsourcing and sub- **contracting** . In the SMART case a high degree of integration is achieved through the joint involvement of suppliers, distributors and the manufacturer in producing and delivering the car. Suppliers are taking over part of the assembly factory and distributors are performing final manufacturing, while sales outlets are involving customers in the "tailoring" of cars interactively and to their specific requirements. Integration is thus a cross-functional and cross-company phenomenon. Figure 2 graphically describes the process: notable is the extent to which the OEM/manufacturer is "squeezed out" of the physical flow of goods, as a result of the extensive involvement of suppliers and distributors.

MCC, the OEM in this case, maintains **control** over the supply chain by **controlling** and integrating the flow of information. They inform suppliers about orders, develop customer know-how by using POS-data and dialogue with customers about products and customer specific demands. Furthermore, they co-ordinate the manufacturing and logistics operations between the various parties involved and their operational style is akin to that of project management, with the delivery of a customized car as the project In line with the reasoning of Rayport and Sviokla (1995) the rich interaction between the flow of information and the flow of goods enables the creation of new products and services, in particular the mass customization of products. What can also be expected is that the chosen form of virtual integration will impact on the type of manufacturing, the approach to logistics, the form of communications, the type of performance measurement, and various other operational characteristics. Table III lists a set of changes observed in the supply chains studied in the survey and the SMART case, for the various functional areas along the supply chain, including logistics. These are supplemented with expected managerial challenges in the years to come.

The contribution of this paper is to confirm that postponement does have an operating basis, applicable along the supply chain, with the aim of achieving mass customization of products and services. There is evidence that postponed configuration and shipment, achieved largely through logistics is the most prominent application of postponement at the present time. For sales and services the application of postponement throughout the chain enables the establishment of a different type of customer interaction. Sales can become more interactive and consultative as customers can be involved in the specification of products, as in the SMART case. The resulting situation is one in which sales data have an important

input in engineering and product composition ("why make anything you're not surely selling?"). As a result, integration can be cross-functional, cross-company and supported by the exchange of data between players in the chain, as opposed to the more traditional, and nowadays restrictive, form of integration based on ownership. Suppliers are being involved in the engineering of products and the manufacturer aims at specifying the overall product architecture while allowing for a strong input from the supplier at the level of modules and components. The task of logistics is to facilitate the seamless integration of manufacturing (including the operation of manufacturing activities in the logistics channel) and sales (in order to achieve high customer service goals).

For the **control** of virtually integrated supply chains a new set of performance measures may have to be developed[1]. These measures will have to adopt a supply chain perspective (i.e. integrated measures) and focus on the contribution of the various functions and players in the supply chain to overall chain performance. For purchasing, the percentage of added value purchased (over 50 per cent in the case of SMART) and the order-delivery lead time (less than an hour in the SMART case) may be relevant measures. For logistics, lead time (4.5 days in the SMART case), which is very short) and fill rates are likely to be relevant. For marketing and manufacturing, various categories of information about suppliers and customers may be important, especially with respect to their ability to integrate into the overall operation and into the information flow.

Table III attempts to look beyond the data presented in this paper for the challenges facing the management of various functions and companies in the years to come. While there is a challenge to increasingly involve suppliers in operations and innovations, the manufacturer must also try to maintain a lead over suppliers by specifying the overall product architecture, and integrating the flow of information. In that respect the manufacturer begins to operate as a project manager, rather than as an operator. In the logistics channel finished goods inventory can be avoided by storing generic components and by combining them rapidly into customized products. All this is in combination with short lead times and direct distribution to the customer, employing the critical role of logistics.

Fundamental to the supply chain concept of SMART is the development of new customer relations in an increasingly competitive market. Interactive sales are used to develop intimate customer knowledge and relations, while the modular production concept is used to keep customers for a prolonged life cycle (i.e. changing modules during the product's usage). The result is close customer relations in which the customer drives the (entire) supply chain.

Conclusions

This paper suggests there are three central elements within the **virtual integration business model** :

- (1) the application of postponement throughout the supply chain;

- (2) extensive outsourcing and subcontracting, leading to

- (3) **control** based on information integration, as opposed to integration based on ownership or the co-ordination of physical flows.

An empirical investigation of factors contributing to the application of postponement has indicated that the (external) application of ICT greatly facilitates customer responsiveness and the application of postponement. Operating characteristics and production and marketing circumstances, however, have to be capable of enabling postponement. The case study of the SMART car, involving a highly innovative supply chain format wherein postponement and outsourcing are extensively applied, demonstrates that

virtual integration is actually happening and creating a major impact, not only on the central manufacturer, but also on the suppliers and distributors. A set of challenges for the structuring of the supply chain, involving virtual integration, has been presented for the various (functional) elements of the supply chain. These challenges explicitly recognize that the information flow no longer is a biproduct of the flow of goods but a primary element of the supply chain format. A thorough integration of the flow of goods and information can lead to the creation of new products and services, new marketing approaches and operations. Most fundamental is the role of virtual integration in changing the customer relationship to one involving a high degree of interaction and direct contact given the ability to mass customize products and extensively involve multiple players and functions based on an integrated information flow (including POS data, planning data and market data).

Note

1. In this regard, the CLM recently (1998) initiated a new study on the measurement of logistics activities in the supply chain.

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Caption: Table I; Constructs and items used in the model; Figure 1; Model explaining the application of postponement; Table II; Results of multiple regression analysis; Figure 2; The decreasing role of the manufacturer in operations; Table III; Challenges in **controlling** and structuring virtually integrated supply chains

DESCRIPTORS: Studies; Logistics; Supply chains; Outsourcing; Information sharing
CLASSIFICATION CODES: 9130 (CN=Experimental/Theoretical); 5160 (CN=Transportation)
PRINT MEDIA ID: 14901

Logistics and virtual integration **Postponement**, outsourcing **and the flow of information**

...TEXT: a number of days (postponed manufacturing). Michael Dell, founder of Dell Computers, calls this the **business model** of **virtual** integration (Magretta, 1998); the company is focused on the individual customer and integrates the supply...

... a function dealing with the physical flow of goods. How does one mange, structure and **control** logistics in virtual supply chains? Three elements of the logistics operating structure appear to be...

... and the large number of (outside) companies involved in the physical sphere. The company achieves **control** not through ownership, but rather by mastering the flow of information while focusing its competitive...

...to customers.

This paper aims to study both these elements and their role in the **virtual** integration **business model** . Two methods are used: a survey and a case study. A survey was developed and...

... as contributing to the creation of a virtually integrated supply chain in which integration and **control** is not based on direct ownership but rather on connectivity in the flow of information...a company attempting to prepare the operations in the supply chain for customization and extensive **outsourcing** , using information **integration** . The case presented in the next section may thus provide further insights into "how to...

...at multiple points in the supply chain, in this case involving extensive outsourcing and sub- **contracting** . In the SMART case a high degree of integration is achieved through the joint involvement...of the extensive involvement of suppliers and distributors.

MCC, the OEM in this case, maintains **control** over the supply chain by **controlling** and integrating the flow of information. They inform suppliers about orders, develop customer know-how...

... the logistics channel) and sales (in order to achieve high customer service goals).

For the **control** of virtually integrated supply chains a new set of performance measures may have to be...

...the (entire) supply chain.

Conclusions

This paper suggests there are three central elements within the **virtual** integration **business model** :

- (1) the application of postponement throughout the supply chain;
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- (3) **control** based on information integration, as opposed to integration based on ownership or the co-ordination...1-12.

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... analysis; Figure 2; The decreasing role of the manufacturer in operations; Table III; Challenges in **controlling** and structuring virtually integrated supply chains

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The driving forces in the virtual society

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ABSTRACT: A culture once based exclusively on physical contact is in the process of being transformed to a culture where goods and services are accessible without the need for face-to-face contact with other people. The virtual society transcends towns, states, and countries, and represents an evolutionary movement.

TEXT: Examining the factors propelling the evolution to a virtual workplace and the arrangements being used to implement these changes in a societal context.

The term virtual society refers to all components that are part of a society's culture based on the functional rather than the physical. It extends to include significant enhanced effects or actions, physical behavior of non-physical entities, and the supporting use of telecommunications and computing technologies. Companies no longer talk about "work at home" programs. Rather, they talk about "work anywhere, anytime" where laptops, fax machines, cellular phones, networks, email, and voice mail are in the state of transformation toward the virtual society. After all, does it matter to the recipient whether that critical voice-mail message was sent from a client's office, an airport, or a traffic jam? The

definition of "Virtual" was extended by Grenier and Metes [21 to include significant enhanced effects or actions, physical behavior of non-physical entities, and the supporting use of telecommunications and computing technologies. A culture once based exclusively on physical contact is in the process of being transformed to a culture where goods and services are accessible without the need for face-to-face contact with other people. Technology enables this transformation toward a virtual society and is the glue that makes virtual societies plausible. However, technology alone does not guarantee the viability of the virtual society; the technical power must be used intelligently and deliberately by an informed population.

The virtual society is a compilation of leadingedge computer, communications, and information technologies and the impact of these technologies on individuals, groups, organizations, and societies. As the number of implementations of the newly formed virtual societies increases, societies face new challenges to cope with their social structure.

Limited research has been conducted to study issues related to the virtual society phenomenon. Although there has been a fair amount of research on the virtual workplace or telecommuting, this research is usually focused on the individual. It does not consider global issues and models for virtual organizations, communities, and nations. Existing research also espouses the positive aspects of interactive communication in a business environment. It ignores the negative elements, is descriptive, and does not consider consumers, politics, and the culture as a whole. An intellectual comprehension of the entire domain of the virtual society-individual, group, organization, community, and world-is an imperative for studying this impending societal form.

The purpose of this article is to review existing articles in academic and business journals within the fields of information science, social science, economics, and management for the purpose of deriving a conceptual framework to study the creation and impact of the ensuing virtual society.

Virtual Society Framework

Technology allows change from 20th-century, physically oriented structures to 21st-century, non-physically oriented communication structures without constraints of place and time. Our discussion follows the model of this virtual society, which is presented in Figure 1. The figure describes an evolutionary model conceptualizing an entity hierarchy for studying the virtual society and summarizes both the driving forces and arrangements that are critical components of this proposed research framework. After discussing each driving force and arrangement, we present three implementation examples.

Driving Forces

The virtual society transcends towns, states, and countries, and represents an evolutionary@ as opposed to a revolutionary, movement. Typical analyses of change-initiative forces include an examination of economic, political, cultural, and social components. This article discusses these macro elements on finite levels-global economies, policies and politics, enlightened and diversified population, and technology.

Global economies. During the last decade, the world has witnessed an unprecedented expansion of business into global markets. Firms distribute value chain activities throughout the world. Globalization is an important emerging business mandate relevant to virtually all individuals and businesses. Firms realize that they need to think globally and be concerned about business beyond their domestic marketplace both for competitive reasons as well as for identifying opportunities for growth and increased market share for their products and services. Firms routinely move an important piece of work, such as a proposal, across time zones and countries so they can work on it literally around the clock. Borders are

becoming transparent for trade as regional trading blocs, such as NAFTA and the European Union (EU), move forward and as global money becomes more of a reality. New IT enables businesses with diverse forms of organization and **control** to operate in multiple countries.

A global economy requires monetary exchange standards. The integration of national payment systems, through which people can execute foreign exchange and operations and payments in different currencies or between residents of different countries, is important to the EU. We can anticipate the acceptance of electronic payment-- electronic payments are becoming commonplace through the direct deposit of paychecks and the use of bank debit cards. New methods for electronic payments, such as E-cash between customers and banks or electronic payments between companies and/or banks, are being developed and piloted in the late 1990s in an effort to improve security, provide anonymity, and reduce transaction costs. These approaches have the potential to change government regulations, the way people view money, and the entire banking industry [8].

Another phenomenon driving the global economy is the rapid adoption of English as a common language by the major trading partners of the world. A common language helps to pave the way for increasing the worldwide adoption of the virtual workplace. Standardization is an inexpensive alternative to interpreters, and the acceptance of English as the global language would significantly simplify trade transactions.

The global efforts to standardize economic issues by enhancing free trade policies, creating robust telecommunications infrastructures, changing the nature of payment and money, upgrading global monetary standards and policies, and adopting a common language for conducting business, are moving us to the virtual workplace.

Figure 1.

Policies and politics. Government policy-making for IT is at a crossroads. Some people believe the market should drive IT policy while others think government intervention is necessary. National IT infrastructure serves the broad public interest and serves the commercial and industrial interests. Concerns have been raised that large businesses and big money will dominate the global marketplace and minimize the ability of the ordinary citizen to leverage the intellectual, social, commercial, and political benefits of global technologies. Clearly, policy and politics will shape the global marketplace.

The world's trading partners have differing views of governments' role in IT implementation. Governments play a major role in emphasizing the importance of telecommunications to national and business infrastructures by building and maintaining national backbones and helping to provide gateways to other nations. Singapore, for example, in 1980, established the first formal IT policy. The National Computer Board in Singapore in 1992 announced the IT2000 Plan to extend the role of IT beyond its domestic needs to embrace the rapidly developing Asia-Pacific region. Some European countries already view the free flow of information as a way to improve their economies and are instituting policies that demonstrate clearly their commitments toward creating a global marketplace. For example, the Danish government is aggressively pushing the country toward a virtual workplace. It has developed a technical blueprint for achieving this goal, including a plan to have 75% of the households equipped with personal computers and modems by 2000 [1]. The U.S. National Information Infrastructure initiative intends to give every school access to the Internet. Although this attitude toward a virtual community is not yet commonplace worldwide, some countries' commitments to building virtual communities are noteworthy because government is taking the responsibility to create the foundation for change.

Enlightened and diversified population. According to projections reported in Workplace 2000 [51 the U.S. workforce is becoming increasingly diverse. Johnston and Packer [51 projected that by 2000, approximately 47% of the workforce will be women and 61% of all women of working age will be employed. It is projected that by 2000, African Americans will comprise 12% of the U.S. workforce, Asians 4%, Hispanics 10%, and women 48%. Further, the nature of jobs will also change, with professional, technological, and sales jobs becoming the fastest growing sectors [10].

The evolution of a virtual society is dependent on having people understand, accept, and implement the consequences of the new society culture. Use of the technologies requires individual computer literacy which, in turn, requires typing skills. Countries in which people learned to type in school and that teach computing in the schools have a temporary edge in working virtually. However, this edge will disappear as older workers leave the workforce.
People need exposure to IT at a young age so they are able to effectively build on their learning and are able to adapt to change. School curricula are starting to offer computer classes in the elementary grades to expose children during their formative years to the ways they can use information to enrich their futures. The passage of time will produce a more knowledgeable group of people with the requisite skills to interact in a virtual workplace.

Information technology and its applications. The interest and growth in the virtual society has been further spurred by advances in technology. Technological advances and the reduction in hardware and software costs have made this phenomenon a reality. Telecommunications and network technology enable us to create the virtual society; however, technology by itself does not ensure the coming of the virtual society. Rather, it is an enabler. Digital technology has made it possible to convert text, sound, graphics, pictures, and motion into a computer language. Codification of data, including text and numbers, as well as multimedia digitalization, allow us to be less time- and location-dependent. These technological advances, plus the emergence of multimedia standards and the shift to distributed computing and internetworking, are providing the raw power for the digital convergence. We are seeing a cornucopia of supporting technologies, including the Inter/intra/extranet, email, groupware, videoconferencing, workflow, data management, data warehousing, and improved networking capabilities.

In the 1990s, the Internet moved from supporting only science and research to becoming an integral tool for commerce. The Internet is at the forefront of the global growth of these enablers. The growth rate in the number of Internet hosts is exponential. For example, in 1995, 148 out of 185 (86%) United Nations members had Internet service, compared to 46% in 1991 [6]. In June 1996, approximately 400,000 businesses worldwide had domain addresses (see rs.internic.net). As of July/August 1997, it is reported that there are more than 4,000 Internet service providers (ISPs) in North America [9].

Interactive communications are required if business is to be conducted virtually on the Internet (or its successors). Email is the foundation for such communication and is available at relatively modest cost, but the simple sending of text messages is not enough. Multimedia applications are increasing the gains of groupware, videoconferencing, data management, and data warehousing in the virtual world. Improved networking infrastructures will underlie the higher bandwidth, security, and reliability that enable this technology.
Internet e-commerce is replacing traditional e-commerce, which relied on value-added and private messaging networks-both of which were relatively expensive and provided limited connectivity. The new technology holds many possibilities for virtual societies. It enables individuals, groups, communities, organizations and societies, among others, to exchange

information, conduct business, participate in newsgroup discussions, and publish information electronically. The new technology enables innovative ways of communicating and doing business. It is an important element of creating the virtual society.

Virtual Workplace Arrangements

There are many possible approaches to workplace arrangements, schemes, and potential scenarios, as discussed here.

Telework. Telework originated with the idea that work could be moved to where the workers are rather than moving the workers to the work. People can work in a variety of locations (at home, a neighborhood office or at a client office) and participate in the work of the organization [3].

Teleworking has grown due to the demands of three constituencies: employees, organizations and society. First, employee demands for more flexible work arrangements resulted from substantial changes to the family structure. Traditional families with a working husband and a stay-at-home wife are down to 10% of American families. The growth of dual-career households, those with preschool-age children, those with older children, and those with a dependent spouse or parent may increase the workfamily conflict resulting from trying to perform multiple roles such as worker, spouse, and parent. Thus, telework arrangements may make it easier for individuals to achieve a better balance between their work and personal lives.

Second, organizations need to make accommodations to attract and retain employees due to demographic changes. The next generation of workers will be much smaller in number than the current workforce. As older workers, who are experienced and trained, retire, the smaller pool of younger workers causes a shortage of needed employees. Flexible work options are expected to be required to recruit and retain quality employees.

Societal demands for environmental awareness are the third factor contributing to the demand for flexible work. Teleworking helps organizations deal with the regulatory requirements of the Clean Air Act and the Americans with Disabilities Act. The Clean Air Act requires large companies to reduce the number of automobiles used to commute to work on a daily basis. Allowing employees to work at home helps organizations to comply with this legislation. The American Disabilities Act requires organizations to make reasonable accommodations for disabled employees to perform their jobs. Allowing physically challenged individuals to telework allows organizations to comply with this legislation as well. Flexible work also provides an organization with a contingency plan to cope with disasters. Recent weather problems and other disasters, such as the Northridge earthquake in California and the blizzard of 1996, which paralyzed the U.S. east coast, all but required employers to consider alternate work arrangements.

On balance, companies appear to use productivity improvements and cost reductions for justifying telecommuting more than they use regulation or disaster-prevention-as- a rationale.

Computer-supported cooperative work. The rapid evolution of information and the new potentials for communication, particularly the increased availability of computer networks and the trend toward teamwork, contribute to the success of organizations. Computer-supported cooperative work (CSCW) is about using teams to support the flexibility in virtual work. CSCW is a computer-based system that supports groups of people engaged in a common task (or goal). It provides an interface to a shared environment. CSCW is a generic term that combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services and techniques. The major change

that computer support (such as Lotus Notes) has brought to teams is the ability to work anyplace, anytime. The two-by-two grid shown in Figure 2 depicts the four combinations of time and place involved [4].

In a **virtual** workplace using different time/different place **communication** , people have the opportunity to decide when they want to communicate, the form of communication, and how the communication will proceed. CSCW systems are often categorized according to the preceding time/location matrix using the distinction between same time (synchronous) and different times (asynchronous), and between same place (face-to-face) and different places (distributed).

Virtual corporations. Vertical integration, in which organizations carry out all their activities themselves, is diminishing. Some corporations outsource part of their work, whereas others create virtual alliances and partnerships. Organizations create alliances with other firms that possess competencies needed to create a specific product or service in a very short period of time. These alliances and partnerships constitute virtual corporations. Virtual corporations are temporary networks of independent companies-suppliers, customers, even erstwhile rivals-linked by information technology to share skills, costs, and access to one another [7].

Figure 2.1

Virtual organizations are established though the use of one or more of the following existing collaborative mechanisms:

Partnerships

joint ventures

Strategic alliances

Supplier-subcontractors

Cooperative agreements

Outsourcing **contracts**

Royalty agreements
Licensing agreements

More complex than the traditional **model** are the **virtual business** relationships, which are created and dissolved quickly. Two companies in partnership on one project may be bitter rivals in another. Differences in corporate culture must be worked out. Ways have to be found to protect company secrets, such as special formulas or marketing strategies.

Virtual communities. Virtual communities emerged from a surprising intersection of human needs and technology. \When the ubiquity of the telecommunications network is combined with the information-structuring and storing capabilities of computers, a new **communication** medium becomes possible. **Virtual** community is a term commonly used to describe various forms of computer-mediated communication, particularly long-term, textually mediated conversations among large groups. It is a group of people who may or may not meet one another face-to-face, and who exchange words and ideas through the mediation of computer networks and bulletin boards. The range of activities is immense. People chat. They argue. They exchange property, ideas and gossip. They plan, make friends, even fall in love. They do everything people do when they meet face-to-face, but by using computers, they do it separated in space and time. Electronic interactions in which people don't know each other make new kinds of communities possible.
The improved **communication** of **virtual** interaction allows people to seek out more easily those who espouse similar beliefs than can be done in a

physical world. For example, Net newsgroups and electronic bulletin boards allow people to share ideas and knowledge on a particular subject. Children and adults spend time surfing the Internet, participating in chat rooms or MUDs (Multi-User Dungeons/Dimensions), redefining their physical and social appearances, or playing "love connection" to find a partner rather than interacting physically. It is unclear whether these activities create homogeneity among people or whether such interactions more often are viewed as a convenience for a particular time. Over time, two extreme outcomes are possible. In one, people become more alike because they are all exposed to the same ideas; in the other people become fragmented into multiple special interest groups that never intersect and hence cannot compromise their differences.

Teledemocracy. The rapid evolution of information and the new potentials for communication, particularly the unprecedented global telecommunications and information networks explosion and the trend toward a global social society, will have profound impacts on various phenomena, such as work, social life, entertainment, education, and democracy (see www.auburn.edu/tann/tann2/editor.html).
Teledemocracy is about using directly empowered citizens to support the flexibility in virtual work and to have meaningful input into the political system. In modern societies, citizens want to shift from being "the governed" into "self-government." They want to be involved actively in the political work instead of being mere subordinates. They want to have more power, authority, and **control** over their own lives. Ordinary citizens can play a major role in helping to decide what kind of society they want to live in. They can take an active role in socio-political decision-making in order to make their lives better and to manage their own affairs. They can participate in agenda setting, planning, and policymaking and they ask for the power to be handed back to them. Technology, now, can easily empower them. It promotes a new form of direct citizen participation and direct democracy-Teledemocracy.

Teledemocracy is a generic term that combines the understanding of the way citizens are empowered with the enabling technologies of computer networking and all of the associated hardware, software, services, and techniques (see www.auburn.edu/ tann/tann2/auli.html). The major change that teledemocracy has brought to societies is to ensure that political decisions are made in accordance with the people's attitudes and desires, to facilitate personal and community evolution, to build social value structures, and to make their future (see www.tcm.hut.fi.).
Teledemocracy has grown due to the demands of three constituencies: citizens, elected leaders, and society. First, citizens' demand for more leverage in self-governance resulted from substantial changes to citizens' perceptions of governments and increased citizen participation in information revolution. Information technology could support increased civic participation by facilitating an informed citizenry. The increased number of informed citizens may increase the need to create a more conscious direct democracy. Citizens need to interact electronically with their elected leaders and hold weekly or monthly electronic meetings. These meetings can establish some accountability between the public and their elected leaders. Holding electronic town meetings may provide a forum for citizens to build a working consensus on major issues and priorities (see www.auburn. edu/tann/ tann2/elgin. html). These may assure that citizens feel engaged, involved, and invested in decision-making and responsible for society and its future.

Second, elected leaders, due to electronic means and social changes and demands, need to realize critical political transformations that may redistribute their political power. Elected leaders need to communicate with citizens, colleagues, and government gencies. They persuade, negotiate, listen, and question to meet stakeholders' desires. Citizens' wishes can push elected leaders to adopt teledemocracy. Teledemocracy can also improve the relationship between citizens and policymakers and

decrease the gap between the governor and the governed.

Societal demands for voicing public opinion and communicating with elected leaders are the third factor contributing to the demand for teledemocracy. Governments may need to increase their funding for telecommunication infrastructures to generate the level and quality of communication needed to support teledemocracy in its process of choosing a sustainable future. Faster, cheaper, more diverse, and more interactive communication have the potential to increase citizen participation and involvement in the democratic process. Local information networks should be designed to promote civic participation by offering government information and communication at little or no cost.

Perhaps a more dramatic change for the future will be a shift in governmental processes. A representative government is used so that people are able to elect others whom they believe will perform governmental rules effectively and follow their ideals. Elected representatives are agents of those who elect them. In a virtual society, these agents may no longer be necessary because people could perform governmental functions virtually (for example, virtual voting on issues, teledemocracy, Ross Perot's suggestions for virtual town halls) - While I foresee an increase in electronic meetings for global commerce, I expect an even greater impact will be made by simplified distribution in the government and political arenas.

Conclusion

The world recognizes the potential of the virtual society as the model most likely to cope with the future. Individuals, groups, organizations, communities, and the world can communicate with one another and do business independent of time zones and geographic locations. A framework to explore the entire realm of the virtual society has been presented here, with an examination of how people can expand the way they work and mix remote interaction with face-to-face relationships. The elements of this framework are both the driving forces that will propel us to evolve to a virtual workplace (global economies, policies and politics, enlightened and diversified population, and technology) and the arrangements being used (telework, CSCW, virtual corporations, virtual communities, and teledemocracy) to implement these changes in a societal context.

This study provides important insights into the forces and the issues in virtual societies. Additional research is needed to examine the relevance of such forces and arrangements in a societal context. We have attempted to develop a framework to explore the entire realm of the virtual society. This framework is aimed at organizing the knowledge from prior literature and identifying the boundaries of this phenomenon. We hope this framework will stimulate additional research in field settings on the driving forces and issues facing the virtual society and contribute to a deeper understanding of the interrelationships among all these forces and issues. Further, the push toward a virtual society appears inexorable and can be both a positive and a negative force. The technology keeps getting better and more sophisticated. However, the determining factors for the essential outcome will most likely be the social and economic forces.

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CLASSIFICATION CODES: 1200 (CN=Social policy); 5250 (CN=Telecommunications systems); 9180 (CN=International)
PRINT MEDIA ID: 17752

...TEXT: becomes more of a reality. New IT enables businesses with diverse forms of organization and **control** to operate in multiple countries.

A global economy requires monetary exchange standards. The integration of ... in Figure 2 depicts the four combinations of time and place involved [4].

In a **virtual** workplace using different time/different place **communication** , people have the opportunity to decide when they want to communicate, the form of communication...

...the following existing collaborative mechanisms:

Partnerships

joint ventures

Strategic alliances

Supplier-subcontractors

Cooperative agreements

Outsourcing **contracts**

Royalty agreements

Licensing agreements

this issue with an integrated business model allowing many alternate process paths through the "functions" of the supply chain to add value and satisfy a customer's requirements (Figure 3).
Organisation structures change to suit their environment and to enable strategic decisions. The Manufacturing 2000 initiative involves forming strategic relationships with suppliers, divesting operations that are not on the critical path of the supply chain and extending the site's influence along the supply chain from the supplier's supplier to the customer's customer. Each of the functional activities in the supply chain is modelled to represent major suppliers, customers, processes and information flows. The part of the model representing the core activities of the Monkstown systems house is outlined in Figure 4.

The number of suppliers that Nortel uses is being reduced, and global agreements are ensuring that the same supplier provides a service to all Nortel sites. They are responsible for gathering material together as required from their suppliers and are being given a view of Nortel's future order load, as a preliminary forecast. It is also expected that some suppliers will accept design responsibility for sub-units of Nortel Networks' products and deliver a completed item. A supply chain "engineering" team was set up with a remit to identify opportunities for standardising processes across product lines and lines of business and for reducing the cost of the supply chain. Another objective was to increase the awareness that processes permeate through the business, and are not limited within functions.
Figure 2.

Figure 3.

Figure 4.

Customers are being offered standard models that reduce the lead-time on delivery. They are given delivery promises and visibility of internal schedules. A new integrated master-scheduling tool is being implemented to co-ordinate orders, and invoices around whatever "systems houses" are necessary to fulfil an order. Customer focus implies a change in the traditional power structure seen in organisations. The most powerful employees are those in direct contact with the final customer. This inverts the traditional organisational power structure (Doyle, 1994). At the Monkstown "systems house" customer focused teams have been set up to represent the customer throughout the life of an order. Each team looks after orders for a particular customer or small group of customers and is ultimately responsible for making the supply chain perform. These customer teams are the "captains" of the supply chain. The customer teams are responsible to the customer, not particular functions, or lines of business within Nortel, or the supply chain.
"Value managed relationships" are being built with key suppliers and key customers to ensure that the maximum value is added to the supply chain at the point where it is most appropriate. Key suppliers are entering stock holding arrangements, direct line replenishment agreements and fast response policies. They benefit by a commitment to long-term business, sole vendor arrangements and early visibility of "future load". Employees from suppliers and customers are being placed in Nortel offices and factories full-time to coordinate activities. One major customer **contract** has been designed, managed, and implemented by an integrated team of about 40 employees dedicated full-- time to that **contract** . They can use their respective contacts in the two companies to maximise the value added in the **contract** . The ongoing move to create the "systems house" as a supply chain owner involves removing what were originally core activities and procuring the services from external suppliers. This has necessitated outsourcing activities, notably materials storage, **contract** electronics manufacturing, field installation, and mechanical and electrical pre-assembly. Where possible this has been achieved by divesting existing operations as "going concerns".

Management commitment

In the early 1990s, Nortel's operations in Northern Ireland were considered to be a "fortress" of manufacturing. There were rigid boundaries, and limits on the flexibility of the business. Since then the research and development facility has grown, and operations have become highly flexible and customer oriented. The local management team in Monkstown has promoted the principles of regional systems houses from before it was selected as a corporate strategy. The assumption of "systems house" status brings responsibility for a large section of Nortel Network's revenue. As the new business environment takes shape, functions are being relocated, replaced by process based teams, or removed. Management has had to make some difficult decisions concerning employment and restructuring but has maintained their commitment to the local community in Northern Ireland.

Due to the company's commitment to empowerment, people with operational responsibility for products and processes make many of the "strategic" decisions. Employees are trained and encouraged to move into a variety of job roles in their careers. Senior managers are champions of core processes and coordinate activities to ensure that overlaps in effort are minimised.

Performance outcomes

The primary measurable performance factor in process-based supply chain activity should be customer satisfaction and loyalty, a core measure in the EFQM model. Customer satisfaction is monitored following regular customer surveys, and from a review of accolades and complaints. In practical day-to-- day terms, it is reflected in delivery performance and commissioning failures. The systems house model is still in its infancy, and the effect of increased customer focus on satisfaction is not readily apparent. However, one unusual factor of success is the number of complaints, or suggestions for improvement. Because the customer is working as part of the supply chain, they are often initiating process change opportunities.The business is changing, and growing rapidly, and business performance metrics show that the integration of the supply chain is not yet complete. Based on the "success factors" of completion, acceptability and achievement (Miller, 1995) an estimation of the success of the Manufacturing 2000 initiative in Monkstown can be made. Completion is about 80 per cent, as most of the infrastructure is in place. Supplier relationships and increased utilisation of outsourcing for design and manufacturing is being negotiated for existing work and planned for future work. Acceptability is near 100 per cent.

Conclusions and recommendations

The purpose of this study has been to understand the nature of the relationship between managing business processes and managing supply chains. It has been found that there is little evidence of organisations actually exploiting the integration of business processes in their supply chains. In the research literature, the two fields are generally treated separately. Business process management techniques are applied to a single firm, although the concept is not bound by company limits, while supply chain research tends to focus on the relationships between organisations. Most studies focused on one member of a supply chain and their links with immediate suppliers and immediate customers.

One common factor of the organisations studied in this report is that they have a total quality management culture and undertake both self-assessment and external assessment procedures. Accreditation of a business with a recognised quality body not only provides market "stature" but also forces managers to look at their own business with fresh perspectives. Management has an important role in the success of a major integration exercise. Senior managers are responsible for providing a vision and common goal.

Empowered teams of process specialists need a clear direction to guide their decisions and strong support to promote the new ideas to the wider organisation.

All process-based management techniques advocate identifying and documenting core processes, and suggest a series of steps to facilitate the changes. The core processes rely on communication of information through them, but are also linked to each other in a variety of ways. Boeing Airlift and Tankers termed their inter-links as "mega-processes". Nortel Networks integrate their core processes by defining sub-processes that are dependent on information from more than one core process. The important aspect of this is to have a communication between processes. This communication may be formalised as a linkage, or relaxed as "chatting" between employees working in open-plan office spaces.

To extend this process integration throughout the supply chain there cannot be a fixed boundary between partners. The supply chain must be managed as a single organisation. Value managed relationships between firms, and the placement of employees in customer and supplier companies enables the formal and informal communication between supply chain members. Processes must be defined as extending from the supplier's supplier to the customer's customer, and acknowledge the flow of information from customer interest to final delivery of a solution.

The model of a globally integrated business being developed at Nortel Networks Corporation is expected to make the organisation as agile as much smaller companies, and more capable of providing global telecommunications solutions than any competitor.
The conceptual model of an integrated business process, shown in Figure 5, has been developed from the practices and ideas discovered during this study. It considers all the core processes as intertwined strands. Communication paths between core processes and between firms and functions join the strands in the supply chain. The model shows three core processes and some examples of points of contact. It provides a holistic perspective on a business that many managers may not readily consider.

Figure 5.

Further research is needed to understand the extent of integration between supply chain management and business process management. In practice, they are often treated as two aspects of the same activity. A quantitative study to assess the opinions and understanding of strategic business leaders about process and supply chain integration would help to determine the extent of integration activities.

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COMPANY NAMES:
Nortel Networks Corp (NAICS:334210; 511210; 541512)
GEOGRAPHIC NAMES: United States; US

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...ABSTRACT: businesses are gaining competitive advantage by maximising the efficiency of their global supply chains or **virtual** organisations. A conceptual **model** of an integrated **business** process, derived from the case study, is presented, which highlights the importance of communication between...

...TEXT: businesses are gaining competitive advantage by maximising the efficiency of their "global" supply chains or " **virtual** " organisations. A conceptual **model** of an integrated **business** process, derived from the case study, is presented, which highlights the importance of communication between...

...procedural approach to BPM and define it as:

A systematic, structured approach to analyse, improve, **control** , and manage processes with the aim of improving the quality of products and services.

De...

... Many employees are uncomfortable with "empowerment", and many managers are reluctant to relinquish their traditional **control** .

Following an analysis of the BPM literature, Lee and Dale (1998) conclude that most definitions... can cause feelings of insecurity in managers who

feel that they are no longer in **control** of their firm's destiny. Also, the unique differentiating culture of particular organisations may be... Total quality culture includes training, teamwork and collaborative people management. It implies some form of **control** measurement and an awareness of the wider business environment. Furthermore, the term implies an integration...

...A&T - Malcolm Baldrige National Quality Award Winner, 1998.

* Design to Distribution (D2D) Ltd - Towards **Contract** Manufacturing.

* Ford Motor Co. - Ford 2000 (The global car).

The grounded theory derived criteria were...industrial sector;

* to operate a large organisation as if it were a small business;

* to **control** the complete global supply chain;

* to align the global operations of the company.

The research... being placed in Nortel offices and factories full-time to coordinate activities. One major customer **contract** has been designed, managed, and implemented by an integrated team of about 40 employees dedicated full-- time to that **contract** . They can use their respective contacts in the two companies to maximise the value added in the **contract** . The ongoing move to create the "systems house" as a supply chain owner involves removing...

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Logistics and virtual **integration Postponement, outsourcing and the** flow **of information**
van Hoek, Remko I
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ABSTRACT: This paper uses empirical findings, from a survey and a case study, about the three (logistics) elements that constitute a virtually integrated supply chain: chain-wide application of postponement, extensive involvement of suppliers and distributors, and the integration of the flow of information. A virtually integrated supply chain differs from a traditional supply chain in that the flow of information is no longer a by-product of the flow of goods but makes an integral contribution to the creation of customer relations, services offered and cross-functional and cross-company interfaces. It was found that information communications technologies are critical in changing the supply chain format to become more responsive to individual customers, while involving multiple companies

and functions. Challenges for the individual functions are formulated based on the findings from the two methods.

TEXT: Remko I. van Hoek: Erasmus University, Rotterdam, The Netherlands

Introduction

"Virtuality" seems to be developing in the international business world at a fast pace. A recent survey among members of a US Council of Logistics Management (CLM) roundtable revealed that logistics managers increasingly seem to focus their efforts on the development of information systems and software tools. This is leading to a new logistics practice or even a totally new business model. Dell computers, for example, has based much of its rapid growth and profits on being almost non-existent in the physical retailing sphere. Dell does not have stores or any other outlets, it does not make products and does not have inventories of finished goods. Instead, Dell sells directly to individual customers through the Internet and call centres. It buys modules and only does the final assembly of products when actual customer orders have been received; and it provides customers with customized products which are delivered directly within a number of days (postponed manufacturing). Michael Dell, founder of Dell Computers, calls this the **business model** of **virtual** integration (Magretta, 1998); the company is focused on the individual customer and integrates the supply chain through a linking up of the chain of information. Dell places far less attention on the vertical integration of the physical flow of goods.

The question can be raised as to what the move towards virtual integration implies for logistics, traditionally a function dealing with the physical flow of goods. How does one mange, structure and **control** logistics in virtual supply chains? Three elements of the logistics operating structure appear to be critical in the example of Dell computers:

- (1) the application of postponement throughout the entire chain (in purchasing, manufacturing and shipment);

- (2) the integration of the chain via information flow; and

- (3) the extensive degree of outsourcing and subcontracting.

Postponement is used to achieve customization and efficiency within one operating system. Integration of the flow of information is needed to achieve a seamless integration of functions and the large number of (outside) companies involved in the physical sphere. The company achieves **control** not through ownership, but rather by mastering the flow of information while focusing its competitive lead on the quality of its responsiveness to customers.

This paper aims to study both these elements and their role in the **virtual** integration **business model** . Two methods are used: a survey and a case study. A survey was developed and conducted among manufacturers to study the role of information and communication technologies in implementing postponement throughout the supply chain. To develop an understanding of the role of integration in the information flow, the supply chain of the SMART car (the new car developed by Mercedes and Swatch) is studied. This innovative product provides an example of how far-reaching the changes in the supply chain structure can be when companies target virtual integration and what the consequences of virtual integration (using postponement and information integration) are for logistics. The findings of the survey are used, in the final sections of the paper, to develop an overview of challenges for logistics and other operations in the virtually integrated supply chain, for the years to come.

Virtual integration

This section provides a short overview of the iterature on virtual integration/ ICT and logistics. A variety of books have been published about the coming of a new economic structure. General management books for example have projected the coming of an information economy or "the digital economy" (Tapscott, 1995) based on the growth of computing and information processing power. With the restructuring of the economy as a whole, business firms have to adjust to the new economics in the business world and it is projected that they need to develop new types of organization and strategy - "the virtual company" (Davidow and Malone, 1992). Part of these new economics is the increasing focus on knowledge development and distribution and using ICT and software to drive an "innovation explosion" (Quinn et al., 1997). It is projected that, given its ever-increasing availability, ICT will restructure transaction cost economics. In particular, external search, monitoring and distribution costs can be lowered so that transaction costs can be reduced significantly, favouring an increased focus on outsourcing, partnering and co-operation among various players (Bradley et al., 1993). This is seen as contributing to the creation of a virtually integrated supply chain in which integration and **control** is not based on direct ownership but rather on connectivity in the flow of information.

Authors have reflected on the specific potential of ICT for individual functions, such as marketing (e.g. McKenna, 1997), purchasing (e.g. Stank et al. (1997) and logistics. In particular, ICT is expected to make the flow of goods transparent (Bowersox and Daugherty, 1995), greatly facilitate the integrated management of physically separated units (La Londe and Powers, 1993), and permit decentralization and centralization to co-exist within individual operating systems. (Bowersox et al., 1992). Among other consequences ICT is expected to enable the application of postponement. Van Hoek et al. (1998) state that "it now is possible" to link the supply chain to individual customers and provide a customized product or service within a short timeframe, at acceptable costs.

Virtual integration and postponement

Postponement is the operating concept that aims at delaying activities until actual customer orders have been received and is used by companies to achieve customization costs hitherto associated with customization costs, such as set-up costs and the costs of storing finished goods. Bowersox and Closs (1996) mention three types of postponement:

- (1) time postponement (involving the delaying of activities until orders are received in time);

- (2) place postponement (involving the delaying of moving goods downstream in the chain until orders are received, thus keeping goods centrally and not making them place specific); and
- (3) form postponement (involving the delaying of activities that determine the form and function of products until orders are received).

Zinn and Bowersox (1988) discuss the application of form postponement in assembly postponement, packaging postponement and labeling postponement. Feitzinger and Lee (1997) explain how Hewlett-Packard combines form postponement of final assembly with place postponement (inventories are centralized at a continental level) and time postponement (delaying shipment to customers until products are finalized based on orders).

The present paper develops the view that the generic types of postponement can be combined and used at multiple points in the chain simultaneously.

A central question is, what factors contribute to the implementation of postponement throughout the supply chain, or, in other words, which logistics operating contexts favour postponements. From Droge et al. (1995) and van Hoek et al. (1998) it can be expected that a strong relationship

between information and communication technology and the application of postponement is a critical requirement. Van Hoek et al. (1998) state that ICT now makes it possible to implement postponement, and attribute inertia in the implementation of postponement over the past decades in part to inadequacies in technology. Indeed the postponement concept was introduced in the 1960s (e.g. Bucklin, 1965) but only recently received major managerial attention, coinciding with the ability of ICT to make the logistics chain transparent enough to make postponement feasible. Droge et al. (1995) state that the application of ICT externally (with suppliers and customers) and internally are critical in enabling postponement.

Based on the foregoing, it can be hypothesized that:

H1A:A positive relationship exists between the external application of ICT and the application of postponement.

H1B:A positive relationship exists between the internal application of ICT and the application of postponement.

Of course there are other contingencies relevant for the implementation of postponement, in particular in the market and the logistics operating environments. Clearly, markets should favour/require the application of postponement and the efficient customization of goods. Droge et al. (1995) point at the relevance of demanding markets in explaining the move towards postponement. For example as customer demands become less and less predictable the viability of postponement increases. When the volume and composition of demand is difficult to predict, obviously the relevance of delaying final manufacturing and shipment of goods increases. The variability of demand often leads to increasing product variety on the one hand, whereas the unpredictability of demand cause inventory risks on the other. When all types of goods are stored in anticipation of possible orders, inventory levels and write-offs may be high, and service quality may even be poor. Finalizing and shipping products only when actual orders are received lowers the inventory of finished goods. When product parts have a high commonality (interchangeability between products) the semi-finished goods inventory can be significantly lower, in comparison to storing all different types of finished goods at sufficient levels to ensure accuracy in delivering finished products (see also Lee et al., 1993 and Zinn, 1990).

The competitive environment can be expected to impact generally on the relevance of postponement. Gilmore and Pine (1997) and Pine (1993) suggest that demanding markets have their impact on the entire competitive landscape, in that:

product life cycles are shortening because of the growing variability of demand and the growing need for customization;

production and product technology frequently has to change with new product life cycles; and

as competitor's actions are difficult to predict in fragmented and heterogeneous markets, marketing policies also frequently have to change.

Pine (19930 presents the changes in the competitive and market environment as a "reinforcing circle" leading to progressive increases in the competitive need for efficient customization. Combining standard modules into customer-specific finished products is mentioned as one of the most efficient options of achieving this required amount of customization by many authors (e.g. Kotha, 1995; Pine, 1993). It is therefore hypothesized that:

H2A:There is a positive relationship between the variability in demand and the application of postponement.

H2B:There is a positive relationship between the variability in demand and the application of postponement.

Apart from the market requirements, characteristics of the operating environment can also be expected to play an important role in the implementation of postponement. Expected inventory savings resulting from postponed final manufacturing were, for example, related to the commonality of components mentioned in formulating H2A and H2B. Cooper (1993) used operating characteristics in categorizing the viability of various postponement applications. Zinn and Bowersox (1988) studied the role of product volume and product variety in the viability of postponing final manufacturing activities. Zinn (1990) pointed at the role of the commonality of modules in the viability of postponement. Van Hoek (1998) argues that not only are the modularity of products and commonality of modules relevant, but also the complexity of the delayed manufacturing activities. Specifically, complex final manufacturing activities (i.e. involving complex combination of knowledge, capital and technology) may favour postponement; delaying these activities until customer orders are received avoids the risk of performing these expensive activities for products that will never be sold. Obsolete inventories are very expensive for these products and the re-working of products may be impractical.

Regarding volume and variety effects achieved in the final stages of the process, a negative relationship can be expected with the application of postponement. If, for instance, volume and variety increases are achieved through packaging and final assembly, inventory carrying costs and the required transportation space increase, thereby raising the cost of work in progress. If variety increases in these final stages of the chain inventory, costs increase because of the variety of products stored. If, in contrast, products and components can be stored in a generic and low voluminous form, by postponing final packaging or assembly, cost can be saved. When viewed in the context of the whole supply chain, however, the operational cost implications of postponed finalization may become less relevant. Postponement is not only relevant in the final stages of the chain but also can be applied in purchasing or components manufacturing.

Customization based on manufacturing activities such as the configuration or functionality of products or the adding of product features can be expected to customize products more fundamentally.

In short, various operating characteristics should allow for postponement and it can be hypothesized that:

H3A:There is a positive relation between the complexity of final manufacturing and the application of postponement.

H3B:There is a positive relation between the modularity of the product and the application of postponement.

H3C:There is a negative relations between the volume and variety increase at the end of the chain and the application of postponement.

H3D:There is a positive relation between the use of manufacturing activities for customizing products and the application of postponement.

Method

Publications about postponement have used case studies (Feitzinger and Lee, 1997; Van Hoek et al., 1998) or analytical models (Lee et al., 1993; Zinn and Bowersox, 1988; Zinn, 1990). These publications have generated multiple insights into the relevance of various factors for the implementation of postponement. Statistical generalizations about existing practice, however, are rare. One of the few studies that did generate generalizations (Council

encouragement and feedback during the preparation of this paper.

About the Authors

Arvind Malhotra is an assistant professor in the Information Technology area at the Kenan-Flagler Business School, University of North Carolina at Chapel Hill. Arvind's research interests are in the area of consumer behavior in wireless and e-commerce environment, impact of e-commerce on supply chains, organizational re-invention for digital business, and adoption of technologies by large firms. He has received four research grants from Dell to explore various research streams such as impact of wireless on industries, measuring e-service quality, and e-business metrics. He is a two-time winner of the SIM International Paper award competition (1997, 2000). Arvind teaches the MBA course in information technology and strategy and an elective course on managing in the wireless age. He has a bachelor's degree in Electronics and Communication Engineering, a master's degree in Industrial and Systems Engineering and a Ph.D. in Information Systems Management from the University of Southern California..

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Robert Carman has been at Boeing/Rocketdyne for 17 years as a Program Manager, initially in Lasers and Optics and for the last 11 years in propulsion. His current program office is called Enterprise Technologies, which deals with business practices, process, methodologies, and information infrastructures necessary to succeed in the 21st century. His passions have been in reduced cost and development cycle time for products achieved through revolutionary change. Prior to Rockwell, Bob was at Los Alamos National Laboratory, Livermore National Laboratory, and the MIT Lincoln Laboratory as a laser and nonlinear optics expert of international recognition, a technical team leader, and as an expert in weapons development within the director's office. Bob has over 75 refereed publications, several book contributions, numerous patents and awards; has lectured in over 10 countries; and has taught in several universities. His Ph.D. is in Physics from Harvard University, his BA is from Adelphi University, and his program management training is from West Coast University.

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handling automation. His current interests are factory modeling and manufacturing planning.

(1.) Robert Zmud was the accepting senior editor for this paper.

(2.) This paper won first place in the 2000 SIM Paper Competition.

(3.) An exception to this is Javenpaa and Leidner's (1999) study of virtual teams that needed to create a shared understanding entirely virtually; however, their focus was on examining how the team's practices led to increased trust, not knowledge-sharing.

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(Graph omitted)

Table 1.

Challenges of a (VC.sup.3) Teams
Management

Factors	In the case of virtual teams...
Objectives of the team	* ...clearly defined objectives and tasks (e.g. software development)
Development of shared understanding	* ...members often bring shared understanding to the team through a common allegiance to a profession or organization
Frequent opportunities for interaction with team members	* ...opportunity for collocation from time- to-time allows for spontaneous face-to-face interaction--albeit minimal
Role definition	* ...roles can be well-defined at outset, aiding team success
Coordination norms	* ...communication protocols about what gets communicated to whom, when, and how, can be established at the outset and aid team success
Management Factors	In the case of Boeing-Rocketdyne (VC.sup.3) Team ...
Objectives of the team	* ...emergent new design with ever changing tasks
Development of shared understanding	* ...shared understanding must be created since there are no common allegiances
Frequent opportunities for interaction with team members	* ...with members having prima obligation to their own company, collocation is infeasible; all interactions were through virtual media only
Role definition	* ...roles must be flexible to respond to emerging task, problem, and solution
Coordination norms	* ...communication protocols are difficult to define upfront since team needs change

Table 2.
Structuring Core Processes for (VC.sup.3) Teams

Core Needs of Creative Teams	Practices of Collocated Creative Teams
Development of shared understanding	* Lead engineer is "spoke-in-the-wheel" for coordinating information and consolidating ideas into new design proposals which constitute the shared understandings of the team.
Frequent opportunities for interaction with team members	* Collocation allows for frequent and spontaneous interaction.
Rapid creation and sharing of context-specific transient information	* Most discussion verbal and undocumented, hard to capture the context.
Core Needs of Creative Teams	**Practices Adopted by (VC.sup.3) Teams**
Development of shared understanding	* From spoke-in-the-wheel coordination (with lead manager/engineer in center) to democratic coordination * Encourage development and use of "common-language" metaphors

Frequent opportunities for interaction with team members	* Coupling use of knowledge repository with synchronous and frequent teleconferences * Allowing for one-on-one discussions when need arises but documenting results for everyone
Rapid creation and sharing of context-specific transient information	* Promote only minimal cataloging of new information--even to the extent of restricting it to "touchstones" and "Placeholders" * Timely and frequent discussions of new entries in knowledge repository to enable members to learn the context

Umbrella Agreement Comes In Handy

One of the companies suffered significant management upheaval during the course of the project and the team members from that organization were pressured to renege on their commitment to be engaged in the design effort. The agreement of equal participation in the effort, however, prevented management from pulling the team members. Thus, the management practice the team found critical to its success was the creation of an umbrella agreement between firms that resolved issues of core competencies, contribution to team efforts, stability of team membership, and open information-sharing before the team was formed so that the team could progress in a supportive context.

Technology Enabler: Coordination Protocol

* Use a pre-specified list of keywords (three key words to describe each entry) in order to facilitate ease of finding entries later on.

* Receive training on the use of the Notebook before starting design work so time during meetings would not be spent in training.

* Create reference links for each entry that was derived from or built on other entries in order to facilitate later recall of the history of entries.

* Create and use notification profiles so that each person would be informed when new entries were created that were of a type they had chosen to be relevant.

* Use templates for agendas, minutes of meetings, action items, and decisions so that a standardized search would yield relevant information.

* Take time before meetings to enter comments on others' entries (to encourage the asynchronous work on the project and appropriate preparation for meetings).

* Create new entries when changes to existing entries are needed so that a train of thought could be observed and the original author could preserve his ideas.

* Copy and paste important entries into the Document Vault for configuration **control** .

* Conduct meetings as electronic meetings (everyone logging into the Notebook at the same time and viewing and revising the same entry) supplemented with audio (as teleconferencing when needed) with everyone's complete attention devoted to the meeting.

* Use the Notebook for all communication and knowledge-sharing needs (including, for example e-mail and file sharing).

* Use the navigation search capabilities to find needed information quickly.

Just-in-Time Analysis

In one distinct illustration, the combustion analyst sketched an idea into the Notebook during a teleconference--an idea that required a certain number of holes to be drilled into a metal plate. As debate raged about the number of holes, the CAD engineer used his desktop CAD tools to create a more detailed CAD drawing of the sketch and then analyzed it. He discovered during the teleconference that the drawing required more holes than there was room for! The combustion analyst was immediately convinced

of the problem with his idea. The team then brainstormed solutions to this problem, yielding a new sketch. This capability to answer questions analytically from the desktop during meetings greatly sped up the design process

Knowledge Retrieval Is Hard

Lead Engineer: "LK and I have just started to talk about how to treat the annulus. They are in the famous HB/LK entry; the one describing the sketch. Which one was that, HB?"

HB: "I forgot."

Producibility Engineer: "Could it be 905?"

Lead Engineer: "No."

Producibility Engineer, looking at another entry: "On the manifold, do you want to cast that flange on it? I thought (another team member) had a better idea. But which entry was that?"

Other team member: "I don't remember which one."

Producibility Engineer: "Is it #867 since that was the last PRO-E model we had?"

Other team member: "I think it's 915; no, maybe 911."

Changing Information Makes Keywords Obsolete

At the end of the project, one team member suggested wistfully: "You know, it would have been a good idea if we had created a new keyword for each new concept so that we could search easier."

Another member pointed out: "How could we? We often didn't even know when we were doing a new concept rather than just a revision to the existing concept."

Metaphors Create a Common Language

Stress tests indicated that the proposed injector would not be strong enough to survive lift-off. The team members struggled with various ways to increase the strength, spending some time trying to "point" out various places where the design could be reinforced. Nothing captured the imagination and consensus until one of the team members suggested that the team add reinforcement to the middle, "like an agitator in a washing machine." That simple metaphor was immediately understood, accepted and used as the basis for redesign.

Guarding Against Alienation

In the words of one team member: "It is very important to me to not feel left out. If I'm not there (meaning not physically collocated at Rocketdyne), I want to know I'm not missing anything."

Incomplete Entries as Catalyst for Knowledge Generation

Halfway through the project, a new combustion analyst joined the team. One of the analyst's first entries was a design concept that had an inaccurate parameter. When one of the team members identified the inaccuracy in a meeting, the analyst simply wrote a comment on his entry by crossing out the inaccurate number and replacing it with the right one, rather than feeling the need to create a new entry with the correct number. This simple act of the analyst changed the dynamics of the team; after that point, the team members began pulling more entries into the repository that were less formal (e.g., spelling errors, for example), and with comments indicating corrections.

Early Warning Signs

* Team not being able to initiate their creative task--bogged down in seeking administrative clearances.

* The collaborative tool not being utilized by team members for the creative task entrusted to them.

* Expression of dissatisfaction with processes by team members in early stages.

* Team process hits a dead end and new ideas not being floated or discussed.

* Sparse knowledge entry into the repository of the collaborative tool.

* Entries are being made into the repository but log files show that team members are not calling up entries.

COMPANY NAMES: Boeing Co. Rocketdyne Propulsion and Power--Management
INDUSTRY CODES/NAMES: BUSN Any type of business; LIB Library and Information Science
DESCRIPTORS: Work groups--Research; Work environment--Research; High technology industry--Management
GEOGRAPHIC CODES/NAMES: 1USA United States
PRODUCT/INDUSTRY NAMES: 8519000 (Research & Development NEC)
NAICS CODES: 5417 Scientific Research and Development Services
FILE SEGMENT: AI File 88

... to the SLICE team, even prior to the conceptualization of the SLICE team, senior managers, **contract** managers, and program managers at the three companies engaged in a ...at each company, referred to as the "Continuous Ordering Agreement." This written agreement defined the **contractual** obligations the companies entered into on how in tellectual property would be defined and allocated...strategy and structuring of conducive inter-organizational work processes and dramatic reassessments of current business **contracts** , practices and processes. Further, all three--technology, strategy and work processes-- will have to ...Review, 1991, pp. 49-58.

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11/9,K/7 (Item 2 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB

11888144 SUPPLIER NUMBER: 59588278 (THIS IS THE FULL TEXT)
E-business: WHAT IS IT AND DOES IT MATTER TO ACCOUNTANTS?
PHILLIPS, PAUL
Management Accounting (British), 78, 2, 40
Feb, 2000
ISSN: 0025-1682 LANGUAGE: English RECORD TYPE: Fulltext
WORD COUNT: 2003 LINE COUNT: 00194

TEXT:
E-BUSINESS IS RESHAPING THE BUSINESS WORLD AS ORGANISATIONS DISCOVER THE BENEFITS OF ON-SCREEN TRANSACTIONS. THIS IS EVIDENCED BY THE RESULTS OF A RECENT SURVEY OF 500 LARGE COMPANIES IN WHICH MORE THAN 90% OF TOP MANAGEMENT BELIEVE THAT THE INTERNET WILL TRANSFORM OR HAVE A BIG IMPACT ON THE GLOBAL MARKETPLACE BY 2001.

The terms `e-commerce', `e-business', `digital economy', `internet commerce' and a myriad of other terms and phases are used to describe the

current electronic business phenomenon. So what does it all mean? According to Tony Mellor of EDS Asia Pacific, all the phrases mean roughly the same. He simplifies the electronic business phenomenon by dividing it into e-commerce and e-business. Electronic commerce is the means by which companies communicate via digital transactions. Electronic business includes e-commerce but also incorporates business being done throughout the entire value chain. According to Mellor companies that have commenced trading electronically with their supplies are experiencing a 20% reduction in costs.

However, it must be borne in mind that the success of the management accountant is not solely dependent on cost reduction, but the ability to perform three broad tasks: product costing, planning and **control** , and decision-making. Although the importance of the first two tasks must not be underestimated, strategic decision-making represents the most important product of managerial endeavours. In today's business environment, organisations are looking for accountants to act as business partners in delivering value to shareholders, manage financial risks, while still maintaining financial **control** . Nevertheless, some writers have queried the current ability of the accountant to provide the necessary information for strategic decision-making. We speculate that tomorrow's winners will be those companies that possess accountants who have full understanding of their industry's long-term growth patterns, corporate profiles, together with an understanding of the most appropriate business model(s) necessary to achieve corporate objectives.

E-business

E-business is reshaping the business world as organisations discover the benefits of on-screen transactions.(1) This is evidenced by the results of a recent survey of 500 large companies in which more than 90% of top management believe that the internet will transform or have a big impact on the global marketplace by 2001.(2) E-business in the USA is soon expected to accelerate into a period of hypergrowth, with Britain and Germany two years later, and Japan, France and Italy a further two years behind. Businesses around the world are therefore on the verge of a revolution, as the web shifts the power from the firm to the customer. Products and services are now being purchased by consumers who are able to obtain more information, and thereby becoming more discerning.

The electronic communication revolution (telephone, tv and internet) will mean that distance will no longer determine the price of communicating electronically.(3) Adept use of e-commerce will become arguably the most important form of competitive advantage for businesses. It has the potential to create new business models and to find new ways of doing things. The benefits of e-commerce come not only from speeding up and automating a firm's internal processes but also from its ability to spread the benefits to other members of its supply chain. E-business will eventually be deployed throughout an entire industry's supply chain, linking manufacturers, assemblers, distributors, marketers and customers.(4) A single press of a button will trigger many processes throughout the chain. Table 1 provides a summary of the strategic implications of e-business. The provision of services will increasingly become more important than mere products. Web pages will deliver bespoke services, such as help for consumers in making their choices or stock management for business partners. Fixed prices will give way to reflect true market worth, and firms will join together to make convenient packages for the customer.

Table 1 Strategic implications for e-business

	E-commerce
Communication	The falling costs and increases in capacity of communications.
Business model	The traditional business model is inappropriate for e-business.
IT	Existing IT systems have not adequately dealt with the customer.
E-revolution	Commoditisation will make it extremely

	difficult for firms to differentiate their products.
Value	The finance function does currently provide much added value in the current e-business environment.

Strategic implications

Communication	Death of the distance.(3) **Virtual** firms can become a reality.
Business model	**Virtual** organisations will be a reality and used to capture cost savings and overthrow established practices.
IT	Traditional IT systems will have to compete with the internet.
E-revolution	Need to refine and implement new e-business strategies.
Value	Redesign traditional financial planning, **control** and evaluation techniques.

King and Clift(4) assert that most businesses will migrate to e-business in four stages:

* Website: organisations make their presence in e-business. Attempts will be made to integrate their sites buying and selling processes into the organisations back office, customer and marketing systems.

* Connect website to supply chain: involves connecting the web site's capabilities to supply chains. For example, it is anticipated that the reduction in paperwork will reduce costs.

* Form alliances: alliances will be formed to operationalise the new business model. Electronic share dealing on the internet is an example of this.

* Industrial convergence: E-business makes it possible for industries to combine expertise and produce package solutions.

The massive scale changes taking place in global markets now make it imperative that organisations (private and public sector) fully understand the business applications of e-commerce and are able to formulate, implement and evaluate corporate, business and operational strategies. We speculate whether accountants are well positioned to influence strategic direction in these e-business times.

Mini case study

Few companies have embraced e-business with more enthusiasm than Cisco Systems, a company that sells approximately 80% of the routers and other forms of networking gear that powers the internet.(5) Cisco is able to sell complex products over the web through its `dynamic replenishment' software through a web interface. The company has been able to integrate the web into its salient business processes. The web is used to provide online answers to frequently asked questions (FAQs). It has been so effective that 80% of customer and partner queries are answered online. Despite Cisco's sales being six times their 1994 level, technical support staff has only doubled. The problems of inaccurate customer orders (more than one in three orders were coming in wrong) and its detrimental effect on working capital have been lessened by the automation of ordering, **contract** manufacturing, fulfilment and payment. In fact Larry Carter, Cisco's Chief Financial Officer, claims that 55% of orders pass through the company without being touched by anyone, and that using the web is saving the company $500m a year.

The e-business accountant: fact or fiction?

In their book, Relevance Lost: The Rise and Fall of Management Accounting, Johnson and Kaplan(6) were concerned that accounting systems and their associated techniques, which were developed during the 1920s, were still being widely used in the dynamic environment of the 1980s. Bromwich(7) suggested that it was perhaps time to release the accountant from the factory floor and help the organisation to meet external challenges. More recently, Tomkins and Carr,(8) who co-edited a special issue of Management Accounting Research on strategic management accounting

(SMA), concluded that the area was ill-defined with no conceptual framework.

It is interesting to note that, despite budgetary **control** being the genesis of strategic management, accountants still focus on budgets for strategic planning.

This has been highlighted by Glueck et al,(9) who observed four phases of strategic management. This has been echoed by Phillips and Moutinho,(10) who, applying Glueck et al's model to the service sector, see the evolution of strategic management consisting of four phases (see Table 2): first, budgetary **control** , where the main focus is the setting and achievement of budgets; second, long-range planning, which focuses on medium-term forecasting; third, strategic planning, where the main emphasis is to think strategically; and then, strategic management, where there is an attempt to alter and create the future for the organisation. Moreover, in the age of one-to-one relationship marketing, e-business has now arguably helped to create a fifth phase, which involves understanding customer needs and customer values.(11)

Table 2 Evolution of strategic management

PHASE I	PHASE II	PHASE III
Budgetary **control**	Long-range planning	Strategic planning
Operational **control**	Planning for growth	Strategic **control** at HQ
Annual budget	Extrapolation of budgets	Strategic plans
Internal focus	External focus	Systematic external audit
Attain budget	Forward planning	Strategic vision

PHASE I	PHASE IV
Budgetary **control**	Strategic management
Operational **control**	Strategic **control** at SBU
Annual budget	Implementation barrier
Internal focus	Suitable planning framework
Attain budget	Competitive advantage

For many accountants, e-business requires new skills and a fresh mindset. A single push of a button means that e-commerce can operate in real time. We speculate that the challenge for accountants is to provide timely and meaningful information through strategic financial analysis which support their firm's decision to invest in e-business.

Pitturro(12) highlights three critical areas that impact the effectiveness of the e-business accountant:

* The cost of the investment in e-commerce can be hard to evaluate, and costs can escalate as the technology is implemented.

* Accountants should weigh the costs, risks and benefits of e-commerce investments.

* Accountants should integrate e-commerce financial planning with IT and other functional processes.

According to Ray Lane, president and chief operating officer of Oracle, the economic structure of companies is changing. Existing financial statements can cope with physical assets. However, they cannot cope with intellectual capital or knowledge, which is the difference between real tangible value and market value. Lane asserts that the real value of a company in the future will be how fast information can be gathered throughout the world, analysed, have value added to it, and then be redistributed back into the value chain. The faster the cycle, the more value that is added to the company.

Many organisations still believe that e-business can be ignored until it is more fully developed. However, according to recent research, e-business will become commonplace, in years, rather than decades, which may be too late for the current non-adopters or those companies that are unable to design and implement the business models adopted by companies like Cisco.

What's next?

We speculate that accountants and their accounting systems have failed to keep pace with the evolution of strategic management, and are currently ill suited for the digital age. If you are willing to share your experiences of designing, implementing or evaluating new e-business models and would like to participate in our project which aims to understand how companies and their internal and external processes evolve through the various phases of e-business, please contact:

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(2) EIU and Booz Allen and Hamilton (1999) see http://www.bah.com/e-business for further details.

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INDUSTRY CODES/NAMES: BANK Banking, Finance and Accounting; BUSN Any type of business; INTL Business, International
DESCRIPTORS: Electronic commerce--Analysis; Online services--Analysis
GEOGRAPHIC CODES/NAMES: 4EUUK United Kingdom
FILE SEGMENT: TI File 148

... on cost reduction, but the ability to perform three broad tasks: product costing, planning and **control** , and decision-making. Although the importance of the first two tasks must not be underestimated...
...as business partners in delivering value to shareholders, manage financial risks, while still maintaining financial **control** . Nevertheless, some writers have queried the current ability of the accountant to provide the necessary...

...function does currently
provide much added value in the
current e-business environment.

Strategic implications

Communication Death of the distance.(3) **Virtual** firms can become a reality.
Business model **Virtual** organisations will be a reality and used to capture cost savings and overthrow established practices...

...revolution Need to refine and implement new e-business strategies.
Value Redesign traditional financial planning, **control** and evaluation techniques.

King and Clift(4) assert that most businesses will migrate to e...and its detrimental effect on working capital have been lessened by the automation of ordering, **contract** manufacturing, fulfilment and payment. In fact Larry Carter, Cisco's Chief Financial Officer, claims that...

...was ill-defined with no conceptual framework.

It is interesting to note that, despite budgetary **control** being the genesis of strategic management, accountants still focus on budgets for strategic planning.

This...

...see the evolution of strategic management consisting of four phases (see Table 2): first, budgetary **control** , where the main focus is the setting and achievement of budgets; second, long-range planning...

...values.(11)

Table 2 Evolution of strategic management

PHASE I	PHASE II	PHASE III
Budgetary **control**	Long-range planning	Strategic planning
Operational **control**	Planning for growth	Strategic **control** at HQ
Annual budget	Extrapolation of budgets	Strategic plans
Internal focus	External focus	Systematic external audit
Attain budget	Forward planning	Strategic vision

PHASE I	PHASE IV
Budgetary **control**	Strategic management
Operational **control**	Strategic **control** at SBU
Annual budget	Implementation barrier
Internal focus	Suitable planning framework
Attain budget	Competitive advantage...

11/9,K/8 (Item 1 from file: 9)
DIALOG(R)File 9:Business & Industry(R)

4014644 Supplier Number: 03750981 (THIS IS THE FULLTEXT)
Virtual pharma: re-examining the impact on business performance.

Pharmaceutical Technology Europe, v 15, n 3, p S23
March 2003
DOCUMENT TYPE: Journal; Overveiw/Profile ISSN: 0164-6826 (United Kingdom)
LANGUAGE: English RECORD TYPE: Fulltext
WORD COUNT: 1478

TEXT:
The 'virtual pharma' vogue of a few years ago has melted away, but during these times of a significantly adverse business environment, it may be

worth a second look. This article re-examines 'virtual pharma' from an operational standpoint, answering what might be a possible model, how might it function, what might the impact be on the profit and loss performance, and is it worth it?

The pharmaceutical industry, whilst demonstrably at the leading edge of drug discovery and research, and in the midst of an informatics revolution, is indisputably lagging behind other industry sectors when it comes to exploiting the connected economy, that is, e-business. The 'virtual pharma' vogue of a few years ago has melted away but, in the now significantly adverse business environment, it may be worth reconsidering.

Future trends

To look into the possibility of a functionally outsourced future for the pharmaceutical industry, one may extrapolate current trends in 'virtual' business practices ranging from a variety of pharmaceutical functions. For example, research and development (R&D) practitioners, such as leading bioinformatics companies Celera Genomics (Rockville, Maryland, USA) and LION bioscience (Heidelberg, Germany) may be good pointers for a new approach in drug discovery. In "big pharma," top 10 pharmaceutical companies such as Pfizer and GlaxoSmithKline, who are exploring new technologies and organizational models to increase R&D performance, could be pioneering future practices that may, one day, become the norm for all companies.

For sales and marketing, most of the pharmaceutical industry is actively exploring the virtual sales representative concept; an ever-present information source in the doctor's surgery. The virtual marketing concept can also be extended to include direct-to-consumer (DTC) advertising, increasing patients' knowledge and awareness, and augmenting patient led initiatives in seeking named medication from doctors.

Only a few pharmaceutical companies get the most economic value out of their manufacturing and supply operations in ways that more manufacturing-centric process industries do. A virtual operation may be a solution to help ease this problem. In addition, few in the pharmaceutical industry exploit outsourced manufacturing to the extent that the connected economy may enable them. Realizing significant business benefits whilst retaining regulatory compliance and improving supply performance may well be much more readily achievable. These all point towards the potential value of operating either as a partly or completely **virtual** company.

The **virtual business model**

The increasingly cut-throat environment of the pharmaceutical industry, coupled with the vast opportunities made realizable by the Internet, suggests that there is a lot of potential for 'virtual pharma.' Indeed, most large pharmaceutical companies already apply aspects of the virtual model to some extent in their operations.

But how would a virtual pharmaceutical company operate? Some of the main questions that would need to be asked include the following:

* What would it trade in and with whom?

* Are there any particular organizational requirements: which functions are needed and which are not?

* What might the possible impact be on the financial performance? (Any economic benefits would have to be very significant.)

Figure 1 illustrates what the **business** model of ' **virtual** pharma' may

look like. The overall **flow** is anticlockwise, starting with a major pharmaceutical company that sees a gap in the market for a product. The next stage is to evaluate and fund the concept, driving investment in both virtual and therapeutically aligned drug discovery, which itself may be outsourced. This ultimately produces candidate drugs for virtual development. Collaboration with third party executors of these functions is vital at this stage, because these activities then provide data for regulatory submissions and manufacturing know-how, which, via web-enabled technology, is transferred to the virtual commercial manufacturing network. The company then selects the virtual sales function, which in turn provides virtual or real information to the pharmacist or doctor, persuading them to prescribe the product. The drug is supplied entirely via the virtual manufacturing operation, integrating with the already existing networks of wholesalers a nd pharmacy benefit managers (PBMs).

Virtual network

It is important to understand what is actually traded between these virtual functions. The model given in Figure 1 can be expanded to illustrate the flow of various commodities across the network (Figure 2). The major pharmaceutical company essentially becomes a 'parent,' dealing in three main currencies:

* intellectual property

* information

* money.

To a lesser extent, the parent still retains functions such as marketing; legal; procurement; regulatory; finance; administration; and human resources. All other activities, including discovery; research; clinical and process development; commercial manufacture and supply; and sales, are outsourced.

The advantages of a virtual network could possibly include

* instant access to advanced technologies

* reduced financial risk

* potentially significant cost reductions (Table I)

* increased efficiency

* adaptability and flexibility

* new drugs are brought to market quicker

* maximizing the profits of marketed drugs by enabling a more dynamic application of product life cycle management (PLM) through increased agility and flexibility across the manufacturing and supply (M&S) network.

The disadvantages may include
* an onus on outsourcing may compromise quality and output, although there is little precedent for this in the pharmaceutical industry

* outsourcing dependency may put third party partners in a strong negotiating position for services, although a legal department should be able to negate this

* a need for, and the associated cost of, setting up the outsourcing

* exposure to third party bankruptcy or takeover; this has traditionally

been the fear factor that destroyed the virtual model during the late 1990s and it may not have completely disappeared.

Being in **control**

Commonly, executives of major pharmaceutical companies feel more comfortable when they are in complete **control** . However, there is little evidence to suggest that this is more beneficial than outsourcing. Indeed, there is anecdotal evidence proving that small **contract** manufacturing organizations (CMOs) deliver better results and benefits. The question that major pharmaceutical companies must now ask is does the increasingly harsh business environment warrant a serious re-examination of the 'virtual pharma' concept?

If the fear of loss of **control** can be negated with tighter management and lower risk using Internet-based technology linking intimately with different business components, could the benefits actually be attained? In addition to the advantages listed earlier, shareholders wilt be concerned about the impact on the profit and loss (P&L) margins. Table I compares the P&L numbers of a typical major pharmaceutical company with a 'virtual pharma' company.

Because CMOs are leaders in their specialist field, they should be able to combine quality with efficiency, supporting claims of operational cost reductions equivalent to 5% of revenue (based on AspenTech economic value calculations (1)), and estimated R&D cost savings of an additional 5%. The benefits to sales and marketing do not directly translate into lower costs, but rather in significantly increased adaptability and flexibility in terms of deployment, training and up/down sizing.

There may also be significant reductions in administration costs--for example, human resources and health and safety would be reduced because the 'virtual pharma' company is a fraction of the size of a major pharmaceutical corporation. However, these savings would be offset by greater legal and procurement costs arising from increased outsourcing activity.

To realize the benefits of the 'virtual pharma' concept, the necessary infrastructure must be evolved and managed in a way that drives out the inherent fear factor. One way to address this issue is to take a function by function approach and build from there. For example, technologies for handling the information demands in outsourced manufacturing and supply are already available and used in more manufacturing-centric process industries. These include collaborative development, manufacturing execution systems (MES), enterprise resource planning (ERP) systems and the different applications of supply chain management from detailed shop floor scheduling to global demand and supply planning. It is the implementation of these web-friendly solutions that are the prerequisites to moving towards realizing the potential benefits of outsourcing to 'virtual pharma.'

Summary

It is not clear whether major pharmaceutical companies will embrace the virtual model. What is apparent is that the squeeze on profits for all companies is very real. The dearth of new products accentuates this problem and recent merger and acquisition activity has not improved the P&L accounts by which success must be measured. There is a strong feeling that something else has to happen. Partially outsourcing entire pharmaceutical functions may well become a more attractive option, but only time will tell. It is worth keeping an eye on.

(FIGURE 1 OMITTED)

(FIGURE 2 OMITTED)

Table 1
Profit and loss account comparison

	Major pharmaceutical company	'Virtual pharma' company
Revenue	100%	100%
Cost of manufacturing and supply	22% (1)	17% (2)
Cost of sales and marketing	25% (4)	25%
Cost of research and development (R&D)	20% (3)	15% (4)
Gross profit	33%	43%
Other metrics		
R&D investment risk	High	Managed/shared
R&D efficiency	Low	Improved
Sales and marketing flexibility	Low/slow	Dynamic/fast
New technologies	Limited access	Broad access
Customer supply	95%	Improved (99%)
Regulatory compliance	High	High

(1) Bear& Sterns/JP Morgan (2001).
(2) Aspen calculation (2001).
(3) RSC (2001).
(4) Estimated from industry knowledge (PSTN).

Reference

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phil.norris@aspentech.com

SPECIAL FEATURES: Table
INDUSTRY NAMES: Pharmaceutical
PRODUCT NAMES: Pharmaceutical preparations (283400)
CONCEPT TERMS: All market information; All product and service information ; Applications; Trends

(USE FORMAT 7 OR 9 FOR FULLTEXT)

TEXT:
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...a serious re-examination of the 'virtual pharma' concept?
If the fear of loss of **control** can be negated with tighter management and lower risk using Internet-based technology linking intimately...

11/9,K/9 (Item 2 from file: 9)
DIALOG(R)File 9:Business & Industry(R)

3345577 Supplier Number: 03345577 (THIS IS THE FULLTEXT)
PLD Makers Confront Inventory Demon -- Logistics Programs Highlight Distribution's Changing Role
(Altera Corp. and Xilinx Inc.)
EBN, p 1
January 21, 2002
DOCUMENT TYPE: Journal ISSN: 0164-6362 (United States)
LANGUAGE: English RECORD TYPE: Fulltext
WORD COUNT: 1028

TEXT:
By: Crista Souza

Silicon Valley -- After years of selling parts almost exclusively through distributors, top PLD suppliers Altera Corp. and Xilinx Inc. are reversing strategy and trying the direct approach.

The semiconductor market collapse that left Altera and Xilinx with the chore of digging out from a year's worth of excess inventory highlighted the need to take the supply chain into their own hands, both companies said.
EBN has learned that in February, Xilinx will launch two six-month pilot vendor-managed-inventory (VMI) programs with one global OEM using fee-based supply chain service providers iSuppli Corp. and Titan Logistics. Xilinx declined to identify the OEM, but named Celestica Inc., Jabil Circuit Inc., and Solectron Corp. as EMS partners.

Under the program, known as **Virtual** Direct, the supply chain service providers will manage the **flow** of information and inventory in a way that's transparent to Xilinx's supply chain partners, allowing Xilinx to have a direct customer interface, said Jane Vaillancourt, senior director of sales and distribution at Xilinx, San Jose, in an exclusive interview with EBN. iSuppli and Titan-a unit of Xilinx distributor Nu Horizons Electronics Corp. will each have geographic responsibilities, which Xilinx didn't specify.

Altera Corp., meanwhile, quietly began deploying a global fee-for-service model last July, working with distributor Arrow Electronics Inc. and at least two of Altera's top six customers, said John Sakamoto, director of North America customer marketing at the San Jose company.

"With this kind of arrangement, we can negotiate terms directly with the OEM and the (**contract** manufacturer) and have more **control** over the supply chain, where before we were essentially just working off of orders from distribution," he said.

Improving Visibility

One of the objectives of the programs is to gain better visibility into the largest PLD users' actual consumption to smooth out supply and demand imbalances. Another is to reduce procurement costs for production-level devices, eliminating the typical 15% to 17% distributor markup.

"The assumption was if we could separate the value of our products from the logistics side it would be less expensive (for the customer). We're testing that model," Vaillancourt said.

For lower volume and new business, Altera and Xilinx are sticking with traditional distribution strategies, which emphasize demand-creation and value-added-fulfillment services. However, analysts note that taking even a few top accounts direct will initially cost distributors a meaningful volume of **business** .

Indeed, the **Virtual** Direct **model** will represent about 75% of Xilinx's business with the unnamed OEM that is piloting the new program, according to Vaillancourt.

"It's a two-sided coin," said Matthew Sheerin, an analyst at Thomas Weisel Partners LLC, New York. "There is potential for distributors to lose significant revenue on the top line. On the other hand, Arrow, Avnet, Memec, and Nu Horizons have logistics businesses they believe can compete effectively with third-party logistics (3PLs) companies."

Sheerin believes this is an opportunity for the distributors to prove the value of their new services, and in the long run, they will contribute to profitability.

At the same time, he said, "it'll be interesting to see whether the iSuppli model, using UPS as a shipping partner, can work on a global scale."

Time For Change

Historically, Altera and Xilinx moved 90% or more of their product through the channel to keep operations lean. But a few years ago, global accounts began clamoring for a distributor-less model that would not layer on cost for unwanted services.
The indirect channel became a liability for the suppliers as well, since the distributor **controlled** the supply chain and the customer relationship.

"The problem with that model is visibility," Vaillancourt said. "We could never tell as a supplier what caused a certain action the distributor put on us. We were so far removed from the actual customer's requirements."

Another supply chain kink was the EMS channel's inflexibility to share inventory between manufacturing sites, Vaillancourt said.

Xilinx's Virtual Direct model will work off of a centralized inventory hub, from which EMS providers can electronically pull product as needed, with a 24-hour delivery guarantee from Xilinx, she said.

In Altera's model, Arrow still holds the inventory, but Altera plays a more active roll in comparing forecasts and monitoring inventory levels throughout the supply chain, according to Sakamoto.

Programs like these represent a major shift from the EMS practice of stockpiling parts, said Andrew Gort, senior vice president of global supply chain management at Celestica, Toronto. But he said all supply chain partners must be equally committed to change if they are to reduce the whipsaw effect of bad forecasts and lax inventory **controls** .

"People have to look at it as an advantage to all players," Gort said. "There is definitely pressure on us for the buffers to disappear. Some of that (buffering) will probably still go on during shortages, but the liability (for custom parts) doesn't go away."

While Altera chose to leverage its longstanding relationship with Arrow

-its only global distributor-Xilinx said it sought fee-for-service bids from its distribution partners and independent supply chain service companies in order to find the most cost-effective approach for individual customer needs.

The aim of the side-by-side VMI trials is not to choose one supply chain service company over another, but to cultivate an assortment of back-end service offerings, Vaillancourt said.

"The intent here, I think, is that this is going to become a way of doing business," said Jan Sanchez, who oversees Titan as vice president of operations at Nu Horizons, Melville, N.Y.
The distributor has been providing supply chain services for four years as an adjunct to its traditional distribution operation, though Sanchez declined to name any of Titan's other customers.

iSuppli, El Segundo, Calif., also confirmed it is engaged with Xilinx on a VMI program, but declined to discuss details of its involvement.

The Xilinx program uses EDI links to send forecasts, build schedules, purchase orders, invoices, and other documentation between supply chain partners. iSuppli and Titan will aggregate forecasts from all EMS locations and send ship and replenishment signals to Xilinx based on EMS build schedules, according to Vaillancourt.

Xilinx will use a combination of the end-customer forecast and the EMS build forecast for its long-term wafer planning. "It's a fairly elegant, fairly simple process that breaks down the elements of the supply chain to a primary level," Vaillancourt said. "But when you layer on how many entities are involved, it becomes quite complex."

http://www.ebnonline.com/

January 21, 2002

COMPANY NAMES: ALTERA CORP; XILINX INC
INDUSTRY NAMES: Electronic components; Semiconductors
PRODUCT NAMES: Integrated circuits NEC (367465)
CONCEPT TERMS: All company; Corporate strategy
GEOGRAPHIC NAMES: North America (NOAX); United States (USA)

(USE FORMAT 7 OR 9 FOR FULLTEXT)

TEXT:
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"People have to look at it as an advantage to all players," Gort said. "There...
?

More complex than the traditional **model** are the **virtual** **business** relationships, which are created and dissolved quickly. Two companies in partnership on one project may...

... telecommunications network is combined with the information-structuring and storing capabilities of computers, a new **communication** medium becomes possible. **Virtual** community is a term commonly used to describe various forms of computer-mediated communication, particularly...

... which people don't know each other make new kinds of communities possible.

The improved **communication** of **virtual** interaction allows people to seek out more easily those who espouse similar beliefs than can...political work instead of being mere subordinates. They want to have more power, authority, and **control** over their own lives. Ordinary citizens can play a major role in helping to decide...

11/9,K/5 (Item 1 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

09443518 Supplier Number: 82851420 (THIS IS THE FULLTEXT)
PLD Makers Confront Inventory Demon -- Logistics Programs Highlight Distribution's Changing Role.
Souza, Crista
EBN, p1
Jan 21, 2002
ISSN: 0765-2046
Language: English Record Type: Fulltext
Document Type: Magazine/Journal; Trade
Word Count: 1139
TEXT:
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PUBLISHER NAME: CMP Media, Inc.
COMPANY NAMES: *Altera Corp.; Xilinx Inc.
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GEOGRAPHIC NAMES: *1USA (United States)
PRODUCT NAMES: *3674120 (Digital Integrated Circuits)
INDUSTRY NAMES: BUSN (Any type of business); CMPT (Computers and Office Automation); ELEC (Electronics)
SIC CODES: 3674 (Semiconductors and related devices)
NAICS CODES: 334413 (Semiconductor and Related Device Manufacturing)
TICKER SYMBOLS: ALTR; XLNX
SPECIAL FEATURES: COMPANY

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11/9,K/6 (Item 1 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB

16061463 SUPPLIER NUMBER: 79150672 (THIS IS THE FULL TEXT)

RADICAL INNOVATION WITHOUT COLLOCATION: A CASE STUDY AT BOEING-ROCKETDYNE (1,2).

Maihotra, Arvind; Majchrzak, Ann; Carman, Robert; Lott, Vern
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Abstract

This paper describes how a unique type of virtual team, deploying a computer-mediated collaborative technology, developed a radically new product. The uniqueness of the team--what we call (VC.sup.3) teams, for Virtual Cross-value-chain, Creative Collaborative Teams--stemmed from the fact that it was inter-organizational and virtual, and had to compete for the attention of team members who also belong to collocated teams within their own organizations. Existing research on virtual teams does not fully address the challenges of such (VC.sup.3) teams. Using the case of Boeing-Rocketdyne, we describe the behavior of members of a (VC.sup.3) team to derive implications for research on virtual teaming, especially for studying teams within emerging contexts such as the one we observed. The data we collected also allowed us to identify successful managerial practices and develop recommendations for managers responsible for such teams.

Keywords: Virtual teams, supply-chain collaboration, innovation, collaboration technology.

Introduction

Suppose there is a ship carrying a team given the task of creating a radical innovation. The product development manager realizes that to achieve truly radical innovation, she must include people who not only have never shared the same ship, but also have never shared the same ocean, the idea being that cross-fertilization of ideas would lead to development of radically new products. That is, innovation will come from bringing people together from different companies, disciplines, products, markets, processes, and industries. Such a ship is hard to steer because the members do not have a common language. They are experts in very different disciplines, different companies, and different products. They share no common history of design, or previous experience working together.

But suppose we are not satisfied with even this possibility of innovation and we realize that, by putting people onto a ship to work together, they are leaving their parent companies. Ironically, we don't want the people who will come--the "best available"--those people the parent company is willing to have leave. We want the best and the brightest that the company has to offer; the person who deeply understands the company's core competency, not just uses it; the "best able," However, because these people are the best, they are already involved in many internal company projects. How do we get them on our ship?

We don't. We dismantle our ship, send everyone home, and create a virtual ship where everyone works on the creative project from his or her desktop, so that team members can remain available to both their parent organization and the creative team. In fact, we make sure we pick people who were never on the same ship so that creativity is the only way out for this team. Such teams essentially become focused SWAT teams, with little history working together, brought together to create revolutionary new concepts on a part-time basis and then disbanded. Because they are virtual, they are never truly "brought together"; rather the members are appointed to the team one day and begin their work from their desktops the next. We call these teams Virtual Cross-value-chain Collaborative Creative teams (or (VC.sup.3) teams).

If inter-organizational creative teams are hard to steer, and if virtual teams in general are hard to steer, then (VC.sup.3) teams are even harder. Moreover, how does a manager facilitate knowledge-sharing in such an environment: where there is no common history to establish knowledge-sharing norms? Achieving the benefit of radical innovation was one of the initial drivers and hopes of virtual teaming (Davidow and Malone 1992; Ring and Van de Ven 1994); thus, for researchers to understand how to ensure effective knowledge-sharing in such teams will contribute to fulfilling this initial dream.

What Does the Virtual Teaming Literature Suggest for Managing a (VC.sup.3)) Team?

Research on virtual teams (Duarte and Tennant 1999; Furst et al. 1999; Johansen 1992; O'Hara-Devereaux and Johansen 1994) has typically examined cross-functional virtual teams within firms. Research on cross-organizational virtual teams is quite limited (DeSanctis and Monge 1999). Existing research has generally focused on managing virtual teams, such as motivating team member involvement (O'Hara-Devereaux and Johansen 1994), enhancing team members' identification with the group or organization (Nemiro 2000; Wiesenfeld et al. 1999), managing group process losses (Finholt et al. 1990), and building trust (Javenpaa and Leidner 1999).

Only a small subset of this research has focused on knowledge-sharing in virtual teams, articulating the types of knowledge content shared, norms developed for sharing, and the effect of knowledge-sharing practices on team outcomes. An even smaller subset has focused on knowledge-sharing in inter-organizational virtual teams This research has found that knowledge-sharing in virtual teams is facilitated by evenly distributing knowledge to all team members (Cramton 1997), communicating knowledge of both content and context (Cramton 1997), ensuring that informal knowledge-sharing opportunities are not suppressed (Kraut et al. 1990), and allowing for decision processes to not become too explicit to be monitored by others (Bowers 1995). Underlying these findings is the long held recognition that effective electronically-mediated communication, collaboration, and coordination rests on a shared understanding among team members about the problem, norms (of knowledge capture, sharing, and use; of work distribution; an d of roles and responsibilities), and context for interpreting knowledge (Clark 1996; Clark and Brennan 1991, 1993; Davenport and Prusak 1997; Dougherty 1992; Krauss and Fussell 1990; Madhaven and Grover 1998; Marshall and Novick 1995).

For the virtual team to have such a shared understanding usually requires that members start with a common set of norms, context, and problem definitions, either because they have worked together previously, or they have worked in the same organization, product line, industry, or discipline. For example, Ahuja and Carley's (1999) virtual team in a research organization consists of individuals with long-standing relationships (some since the early 1980s). Wiesenfeld et al.'s virtual teams were from the same sales department of a company.

For some virtual teams, there is no shared understanding when the team is initiated because the team members belong to different companies with no previous working relationship. In this case, the shared understanding must be created. Most virtual teams studied to date that must create (rather than use) this shared understanding do so by collocating the team members for a period of time at the beginning of a project when the work process is the most creative, contentious, and likely to require significant consensus-building (DeMeyer 1991; Haywood 1998; O'Hara-Devereaux and Johansen 1994; Zack 1993). (3) Once shared understanding is created, team members and tasks are dispersed back to their home organizations and locations, with future discussions coordinated through computer-mediated communication using the shared social context generated at the outset. For example, when Daimler and Chrysler merged, they organized a virtual team of people from the purchasing departments in Detroit and Germany. The cultures an d procedures of the two companies before the merger were so different that, initially, the virtual team

members had difficulty even communicating. Team members were then brought together for a multi-day meeting and social activities to 'get to know each other" and then sent back home to continue their purchasing activities as a virtual team.

Bringing a team together in a single collocated meeting may be feasible if the teams task is constrained to a limited set of possible solutions using a known decision process. In this single meeting, the solution space, decision process, roles, and responsibilities can be decided upon and people can disperse to work on their tasks. However, there is a limitation to this model of virtual teaming in which collocation creates the shared understanding. This model presumes that the concept, roles, context, and norms can be created at the outset in a collocated meeting and the virtual team's task is to refine or carry out these expectations. But what about the dynamics when it is the creation of the initial concept itself that is the task of the virtual team?

When the task is a highly innovative one, as is the case with (VC.sup.3) teams, the methods used to create shared understanding for teams that can distribute their work or follow routine work processes may not apply. Creative work is substantially different from routine problem-solving in the following ways:(1) solutions demand synthesis of domain specific knowledge (Kalay 1989), (2) solutions are generated in unpredictable ways (Safoutin and Thurston 1993), (3) tools to evaluate ideas are without precedent so that both the analysis and solution need to be generated concurrently (Henderson and Clark 1990), (4) the design process is a series of seemingly unresolvable tradeoffs, with priorities among tradeoffs emerging as the design progresses and the process gradually builds a consensus around the solution that meets these priorities (Fox 1993), (5) problems are often not well-specified, being understood only as they are solved (Sage 1992), (6) tasks cannot be easily apportioned to individuals since everybody makes an unpredictable contribution to the process (Hubka and Eder 1996), and (7) expectations evolve (rather than are fixed and followed) about the task, work, collaboration, context, jargon, and assumptions (Gabarro 1990; Krauss and Fussell 1990).

While there have been studies of virtual teams characterized as innovative, the teams rarely fulfill all of these characteristics of highly innovative cross-value-chain teams. For example, while software development is typically considered an unstructured and non-routine task (Kraut and Streeter 1995), software development is divisible, i.e., it is decomposable into small modules to be developed independently, with the modules integrated into a common product. In fact, this is considered best-practice software development. This divisibility does not preclude informal interaction, but it does allow some work to be accomplished without interaction as well as the clear assignment of roles--features not found in highly innovative work.

These characteristics of highly innovative teams suggest that a single collocated session is insufficient to work out the expectations about the process, problem, or solution in (VC.sup.3) teams. In non-virtual creative teams, continuously collocated meetings would be held to allow the shared understanding to evolve as new information and ideas are developed. However, continuously collocated meetings violate the precept and associated benefits of virtual teams. Moreover, these characteristics of highly innovative teams call into question the applicability of existing theories used to explain behavior in virtual teams. For example, Jarvenpaa and Leidner point out that Meyerson et al.'s (1996) theory of swift trust assumes clear role divisions and periodic face-to-face meetings. As another example, McGrath's (1991) time, interaction, and peformance theory suggests that consensus formation is best reserved for face-to-face. But, if the team is continuously in a consensus-formation mode, as is the case in a team generating, evaluating, modifying, and discarding new design alternatives each week, this would suggest that consensus formation cannot occur virtually. We argue, therefore, that highly innovative decision processes demand virtual knowledge-sharing that is distinct from the knowledge-sharing typically observed in research on virtual teams. Table I summarizes the distinctions.

The opportunity to observe a (VC.sup.3) team over time allowed us to address certain fundamental questions about how to manage the knowledge-sharing process in (VC.sup.3) teams:

* In what ways do processes of collocated creative teams need to be adapted to suit the knowledge-sharing needs of a (VC.sup.3) team?

* How are the obstacles of a lack of initial shared understanding overcome in a cross-organizational virtual environment? What impact does it have on knowledge-sharing in the team?

* How are the obstacles to knowledge-sharing among team members overcome in a virtual environment?

* How does the team ensure that team members do not feel left out from the knowledge-sharing process of the team, especially if certain team members resort to in-person, one-on-one interactions with some collocated (or nearby) team members?

* What steps can be taken or roles created to make sure that appropriate knowledge is stored in the best possible manner for future retrieval and is accessible to team members with minimum search effort?

These are some of the issues that were addressed by Boeing-Rocketdyne and several other partners in a (VC.sup.3) team. The team succeeded beyond management's expectations. The authors of this paper were fortunate to be able to observe the team closely throughout its 10-month life and learn how the team eventually addressed these issues. It is their story to which we now turn.

The Case of Boeing-Rocketyne

The team, called SLICE for Simple Low-cost Innovative Concepts Engine, was initiated by Boeing-Rocketdyne, the major manufacturer of liquid fueled rocket engines in the United States. Rocketdyne's rocket engines were facing new competition in an expanding market driven by the need for commercial launches of communications satellites. Rocketdyne's business objective with SLICE was to be able to drive the cost of a rocket engine down by 100 times, be able to get the engine to market 10 times faster than it had been able to for the Space Shuttle main engine, and increase the useful life of a rocket engine by a factor of three. The breakthrough nature of this task cannot be underestimated: in the beginning, none of the senior technical managers at Rocketdyne--who collectively had hundreds of years of experience designing rocket engines--thought that it was possible; only an advanced program manager was willing to try it.

The key participants in the SLICE team included eight people: a project team leader, concept designer, lead engineer, combustion analyst, and thermal analyst from two different geographically-separated organizations in Rocketdyne; a manufacturability engineer and CAD (Pro-Engineer) specialist from Raytheon (then Texas Instruments) located 1,000 miles away, and a stress analyst from MacNeal-Schwendler Corporation, located 100 miles away. These individuals were picked to work on the team because of their highly valued (world class) expertise in their specialty disciplines. Team members from Raytheon and MacNeal-Schwendler, as well as the project leader, did not have rocket engine design experience, so the team did not share a common understanding of the process by which rocket engines are designed. The team members had never worked together on previous team activities and thus they did not have a common set of norms for coordinating. The team worked for 10 months on the project, with no team member devoting mor e than 15% of his or her time. Since time was precious, the team opted to minimize travel; as a result, the only time that all members were collocated at a team meeting was the last day of the project at the final technical review and celebration. However, at the one-day kickoff session, in which the team received training in the collaborative tool, six of the eight members were present.

The team faced many challenges. They needed to solve a product development problem in a truly innovative way. The team needed to perform its work virtually without the benefit of face-to-face meetings using a new collaborative technology (see Figure 1). The team was comprised of people from different disciplines, different product experiences, different organizations, and different design processes who had never worked

together. Finally, the team needed to converge on a design idea that was acceptable to Rocketdyne senior management's conservative perspective, since it was senior management who needed to approve the design for formal testing.

SLICE Team: The Success Story

Despite these challenges, the team was a runaway success. The team successfully designed a thrust chamber for a rocket engine made of six parts instead of the normal (sim)1,200 (a 200-fold decrease in part count), a manufacturing cost reduction from $7 million to $0.5 million (a 14-fold decrease), and a predicted quality level of 9 sigma, meaning less than one failure out of 10 billion, instead of the current industry best-practice of 6 sigma and more conventional 2 to 4 sigma for rocket engine combustion devices. In addition, the normal first unit production cost of $4.5 million was reduced to $47,000. The team was able to achieve all of this with no member serving more than 15% of their time, within budget, within 10 months instead of six years, with more than a 50% reduction in total engineering hours compared to traditional teams. On the basis of a formal end-of-the-project technical review by the seven senior technical managers, the project was judged as successfully achieving its objectives. The manager s approved the design for the next step in the development process: a cold-flow test assessing the validity of the analytic assumptions of liquid flow through the parts.

Fortunately, we were able to closely trace the lifecycle of the team using several data collection methods: ethnographic observation, panel questionnaire surveys, interviews, "lessons learned" group meetings, and weekly logs of collaborative technology usage. One of the study authors became a participant observer in the team's process, attending all 89 virtual meetings and analyzing all 651 entries in the Collaborative Technology referred to as the "Internet Notebook" (using the metaphor of an Engineer's Notebook) and a Project Vault (for the files unlikely to change). The entries included requirements, major models and analyses, budgets and schedules, as well as briefing charts and other documents, creating a single source of product and process data. The log of the activity of the team members in using the Notebook and the Vault were examined to determine which functions of the technology team members used. Finally, a lessons-learned session was conducted with senior managers of the project.

Patterns across these data were investigated to identify those management practices that seemed to contribute to the success of the team. We found three such practices were needed in order for this (VC.sup.3) team to succeed:

(1) Strategy-Setting: Establishing an umbrella agreement in advance of team formation

(2) Technology Use: Using collaborative technology not only to collaborate but also to manage knowledge

(3) Work Restructuring: Restructure work processes without changing the core creative needs of the team

We elaborate each of these management practices, using examples from our case to illustrate our points.

Management Practice 1: Strategy-Setting--Establish A Virtual Teaming Umbrella Agreement Preceding the Creative Team Project

Prior to the SLICE team, even prior to the conceptualization of the SLICE team, senior managers, **contract** managers, and program managers at the three companies engaged in a series of discussions and negotiations. The three companies were identified through a series of discussions in which best practices were shared and the skills of employees were discussed. These discussions took about a year and focused on identifying the complementary skills that each partner company could bring to a creative design process if one became needed, the compelling business reasons for each company to share their resources and the skills and knowledge of their employees in a cooperative venture, and solutions for handling the risks associated with such a cooperative venture. Resulting from these meetings was a fairly simple written agreement between the top managers at each company, referred to as the "Continuous Ordering

Agreement." This written agreement defined the **contractual** obligations the companies entered into on how in tellectual property would be defined and allocated, how company confidential information would be protected, how liability would be allocated, etc. Importantly, the agreement specified the level of participation of member companies to a virtual team, ensuring that one company would not dominate the process, nor reap the majority of the rewards. This umbrella agreement did not refer to a particular project or task order, but was instead intended to cover specific task orders when a particular business opportunity arose to warrant the companies teaming on a particular project.

To have had senior managers at each company sign this written agreement required many additional non-written agreements. These agreements had as much to do with trust and understanding between similar-level managers at the partner companies as it had to do with the specifics of how the agreement would be implemented within each company. A critical part of creating the trust involved clearly defining how the risks were to be managed in each company. For example, one senior manager would only agree once he was convinced that the senior managers at the other companies perceived each company's core competency in a design effort in complementary and non-competitive ways. A senior manager at another company was quite concerned about the use of his engineers on design projects not currently part of his organization's product portfolio and showed no interest in teaming until he was convinced that the arrangement would broaden his company's product portfolio in strategically meaningful ways. Another part of creating t he trust was working out how project responsibilities would be handled. Typically, project activities and budgets are subdivided between organizations, having the effect of organizations focusing exclusively on their own deliverables and budget. In addition, the agreement called for the creation of only a team statement of work when the time for a specific statement of work was required. The team statement of work would not decompose the task into tasks specific to each company. Moreover, there would be only one team budget without breakouts for either companies or individuals. This type of an agreement forced the responsibility and associated budget for the entire team effort to be allocated to all team members and allowed them the discretion to reallocate resources as needed across organizational boundaries. Every activity, therefore, was placed in the context of the total project scope and budget.

Having the Continuous Ordering Agreement in place proved critical to the success of the team. First, since it covered intellectual property and confidentiality arrangements, the engineers on the team reported that they could openly share information since they did not have to worry about management's concerns about sharing information. Second, having the agreement in place meant that, when the business opportunity for SLICE did arise and a purchasing agreement with a statement of work needed to be generated and approved before work could start, the elapsed time from idea to project kick-off was dramatically reduced (from months to days). Finally, having the agreement in place protected the team from management changes (see the box: Umbrella Agreement Comes in Handy).

Management Practice 2: Collaborative Technologies are Knowledge Management Technologies

The team's collaborative technology--the Internet Notebook and the Project Vault--were explicitly developed by a third party in response to a list of requirements specified by several team members. The notebook technology allowed members to securely access it from anywhere; to create, comment on, reference-link, search, and sort entries that could consist of sketches, snapshots, hotlinks to desktop applications, texts or templates; and an electronic white board that allowed for near-instantaneous access to the same entry (see Figure 1). Thus, from the outset, the team had the advantage of having a technology explicitly suited to their initially defined needs. The team focused their early discussions on creating a coordination protocol for facilitating its collaborative use (see the box: Technology Enabler: Coordination Protocol). The Project Vault allowed secure common file storage and transfer for these files, both large and small, on an as-needed basis. These capabilities thus created the

immediately accessible single source of both product and process data for all enterprise-wide activities associated with the project.

The protocol the team developed made team members change the way they normally worked with other engineers in fundamental ways: from face-to-face discussions to complete reliance on technology for collaboration, from sharing information on a need-to-know basis to sharing all information with everyone on the team all the time, from using personal collaborative tools (e.g., different e-mail applications across the companies) to using a single one. Initially, then, with this coordination protocol, the team made a statement that said: all information will be entered into the notebook and shared among all members all the time.

Over time, this protocol needed to be modified in critical ways. Most of the modifications came not because collaboration was difficult using the technology but because the management of the knowledge became difficult. One such example of this need to develop new norms for managing knowledge occurred very early in the project. The team quickly discovered that there was too much information being generated to be captured and that much of the information was likely to have only transient utility (e.g., as new designs are generated, old designs, discussions, and analyses are of limited value); thus, their expectations that they would document everything was just too cumbersome. To manage the overwhelming amount of knowledge needing to be conveyed, the team learned to couple written documentation (as entries) with oral communication. That is, the project team leader began to call for twice-weekly brainstorming sessions using teleconferencing coupled with the Internet Notebook (eventually yielding 86 "virtual meet ings" in total or about 2.5 per week). In preparation for each meeting, team members would post incomplete entries, which would then be the source of much discussion during the teleconference. Thus, ultimately, the team followed the protocol by sharing all knowledge with everyone--but only because everyone was required to be on the teleconference and logged into the network and view documents.

Another example of the team needing to modify its coordination protocol to accommodate knowledge management issues was the initial total reliance on the collaborative technology; i.e., the prohibition of face-to-face discussions on the project when chance encounters between project members occurred, as they occasionally occurred when some members saw each other at another meeting or in the company cafeteria. Three weeks into the project, one member of the team let slip in a teleconference that he had had a face-to-face conversation with another team member; the remaining team members indicated that this was against the coordination protocol and much discussion ensued. In the end, the team agreed that the issue was not one of enforcing a rule that prohibited face-to-face conversations but to ensure that knowledge gained during face-to-face meetings was shared with all. All team members, therefore, agreed to create entries that would briefly describe the results of face-to-face meetings from this point forward. This was critical to maintaining a feeling of "equality" among team members.

Yet a third example of the team modifying its coordination protocol to accommodate the complex knowledge management issues was the protocol that insisted that team members would devote their exclusive attention at all virtual meetings. The team quickly learned that collocated workers on other teams from their parent company often interrupted busy team members during lengthy teleconferences to ask questions. Initially, team members negatively viewed these interruptions and a team member's willingness to succumb to these interruptions, even temporarily, during a teleconference. However, overtime, the team began to realize that the issue was not having the team member's complete attention during a teleconference (since, often times, highly specific issues were discussed that did not have immediate consequence to all members), but rather having the team member's knowledge immediately available during a teleconference when needed. Thus, a team member might be answering a question from someone at the parent company , but then return to the teleconference when the project leader called, "Dick, we need you now; please return." Thus, the coordination norms shifted from providing complete attention to lust-in-time

knowledge-sharing." This acceptance of just-in-time knowledge sharing had an additional benefit. Since team members were located in their own offices with their own powerful desktop tools, and given "permission" to perform multiple tasks simultaneously, team members began to use their powerful desktop analysis packages to analyze designs during meetings. This is an activity that would normally have been conducted "off-line" and it would have taken days to get everyone back into a room to discuss the results. Instead, doing just-in-time analysis provided immediate feedback about the feasibility of a design idea, saving the team weeks in the design process (see the box: Just-in-Time Analysis). Extension of these ideas led to a redefinition of the concept of a meeting, from conventional meetings via telephone to meet ings as work time where all tools and skills are with you in the "meeting."

Our conclusion for management practices, then, is that the key to designing collaborative technologies for (VC.sup.3) teams is to recognize that it is a collaborative knowledge management system that is, in reality, being designed and used. Thus, capabilities should be designed to facilitate knowledge management, and norms to encourage knowledge sharing and reuse should be identified. We believe that knowledge management even with a good collaborative tool is a very messy process and this team benefitted from "far-from-perfect" practices.

Yet, even though the team eventually had over 1,000 entries to search in the Notebook, and even though searching occasionally took 10 minutes of a 45 minute teleconference (see the box: Knowledge Retrieval Is Hard), the team never found it desirable to use reference linking, multiple keywords, and more than rudimentary search capabilities (by a first keyword or the date). For example, only 37% of the entries had two or more keywords (not the three stipulated in the Protocol). Why did the team profess to be interested in sophisticated knowledge management (i.e., knowledge capture and retrieval) capabilities but rarely use them? Upon further inspection, the reasons became clear: the team was generating so many new ideas (20 conceptually distinct design ideas were generated and evaluated) in such quick iterations that most of the knowledge in the repository was obsolete, and that which was not obsolete could be reasonably easily remember ed and found by someone on the team, when needed. In other words, the tool did not (and could not) have a functionality to automatically determine when something was obsolete, and no one on the team was interested in "cleaning up" after a design idea was discarded. It is not just that the task of attaching keywords can be onerous for the team members whose primary role is to creatively conceptualize new products. Even if they tried to classify the entries according to keywords, very soon they found that information was changing too rapidly for them to gauge the nature of entries, let alone classify them based on keywords (see the box: Changing Information Makes Keywords Obsolete).

Management Practice 3: Restructure Work Without Changing Core Creative Needs

In the beginning, the team thought it essential to completely restructure every work process it used in order to adjust to the virtual teaming mode: from the engineering tools to how decisions were made, from how meetings were run to how design ideas were generated. Over time, however, the team learned that while work processes needed to be restructured to accommodate the virtual nature of the collaboration, restructuring should not affect the basic creative needs of the team. The team learned that its ability to be creative rested on having three requirements met:

* a shared understanding of the problem, possible solutions, analysis methods, and language,
* frequent interaction with all team members in order to share work-in-progress, brainstorm ideas, and test out solutions, and
* rapid creation of information that is highly context-specific (i.e., specific to a particular conversation or problem) and then equally rapid discarding of information.

Creative Need 1: Create a Shared Understanding

To create a shared understanding within a creative team, the team

initially adopted the common practice found in their best-practice design teams of centralizing the process around the lead engineer, who determined what needed to be shared about what. The concept behind "heavyweight" lead engineers is that they listen to different ideas from the different specialists and then offer new design solutions that meld the different perspectives. Because of their best-practice experiences, the team members encouraged the lead engineer to take a centralized role in the coordination of information.

Despite initially agreeing on a centralized role for the lead engineer, team members quickly found that, since a single repository was being used to hold all the information, team members became knowledgeable not just about the information the lead engineer wanted to discuss with them, but about all the information concerning the project that had been entered. This meant that team members were commenting on all aspects of the design, not just the aspect that was aligned with their discipline or the aspect that the lead engineer was interested in discussing with them. Individual team members reported that they found this enhanced participation to allow them to be more productive as well as lead to a more exciting involvement in the project. While the lead engineer at first chafed at this change, he eventually accepted the less centralized role. However, for all members of the team to fully participate in all aspects of the design, the team found it necessary to develop a common language for brainstorming. Effo rts to use discipline-specific or product-specific language failed since members were not all equally versed in each other's discipline or product. Instead, what worked was the use of "common-language" metaphors (see the box: Metaphors Create a Common Language).

Without shared artifacts, shared understanding suffers. To accelerate the development of shared understanding, then, managers of VC (3) teams need to help the team create shared artifacts quickly. One way the team did this early on was the creation of an entry in the Notebook that contained an empty matrix listing the 12 designs generated to that point. Each team member was requested to evaluate each design for its likelihood of meeting the functional requirements of each analyst's area of expertise and to insert the results of this evaluation into the matrix. The team obliged and found the process enormously valuable--not for the outcome (the design receiving the highest evaluation was eventually discarded) but for the shared understanding about the design process that the matrix created. In the words of one team member, "With that entry, I felt we were a team and we knew our role on that team."

Creative Need 2: Engage in Frequent Interaction

In collocated teams, team members frequently report that some of the best discussions occur spontaneously, based on frequent interactions with collocated workers. Carrying this into the team's virtual environment, team members expressed concern that one-on-one conversations would harm the team since it could lead to members feeling left out, or feeling inadequately briefed about information critical to their performance on the team (see the box: Guarding Against Alienation).

Thus the team replaced one-on-one conversations with frequent all-team conversations. The team also handled this frequency of interaction issue by broadening out the definition of interaction to include posting of entries to the knowledge base; team members who reviewed postings were virtually interacting with members. To facilitate frequent posting and review of entries, the team leader forced the use of the Internet Notebook for all file-sharing and information-sharing; for example, project management plans, status reports, budgets and cost sheets, meeting agendas, meeting announcements, and meeting minutes were all posted exclusively through the Notebook. In addition, initially the members were reluctant to post entries in the repository because they had the impression that entries should be complete before posting; in the words of one team member, "this repository might be subpoenaed in the future if there is an accident on the launch pad." Over time, however, team members became less concerned about the completeness of entries and more concerned about sharing entries. In fact, incomplete/inaccurate entries became seen as a source for healthy

discussion, which in turn led to new knowledge creation (see the box: Incomplete Entries as Catalyst for Knowledge Generation). Ultimately, the continuous sharing and documentation of work in progress was one of the biggest shifts from the norm for the engineers. Instead of each "engineer" accepting a work assignment, working it to its end, assuring its correctness, and preparing a pretty method to present his results to the rest of the team, team members presented their ideas and sketches, relying on past experience and expert judgment. The more detailed analysis followed when ideas stabilized.

Creative Need 3: Rapidly Create Context-Specific Knowledge

Twenty designs were generated in the course of the 40-week project, with most designs having less than one week of life before being discarded. To rapidly create designs, team members from the different disciplines would come to each teleconference with design sketches that would have been entered immediately prior to the meeting; then, during the meeting, team members would modify the sketches using the electronic drawing board capability while explaining the reasons for the change and how the change was intended to affect the design parameters. The team found that drawing sketches by hand during meetings was too time-consuming and thus modifying existing drawings was much more efficient. In addition, the team also came to realize that sketches could not contain all the information necessary (because no member wanted to spend the time to refine or elaborate the sketch for communication to others). Thus, the highly context-specific knowledge of the design (e.g., "this sketch presumes that we use X type of mat erial" or "this sketch assumes that the fluid will flow in the following manner after take-off") were saved for the teleconferences when each sketch was discussed and redesigned. Team members felt that this process encouraged members to enter sketches, albeit incomplete ones, and allowed members to focus their discussions on the assumptions of the design as they were made explicit in the conversations.

Summary of How to Restructure Work with (VC.SUP.3) Teams

Table 2 summarizes the way the SLICE team managed their core needs, comparing these practices to those often used in collocated teams or virtual teams where concept development is done in a collocated fashion. In sum, then, we found that the team was able to function successfully because it changed its work processes to meet its core needs. That is, the core needs of creative teams do not change just because the team becomes virtual and inter-organizational; how these needs are achieved, however, will change.

Not only were new practices needed in setting the strategy through an umbrella agreement, in designing technology that evolved with the team's needs, and in identifying work processes that facilitated the creative effort, we found that effort devoted to each practice area-strategy, technology, and work-was different over the life span of the project. The team found that strategy practices needed to be put into place before either the work or technology practices were initiated.

In addition, the team found that their dependence on the technology and coordination protocol (albeit one that eventually changed) required that the technology needed to be in place before the team's work process started. In fact, the team start was delayed several times while the technology was being debugged. Once the technology was in place, however, the team learned that it needed the ability to modify the technology as its work processes were adapted. In fact, 23 versions of the technology were created during the course of the project, in large part the result of complaints lodged by team members to the technology developer. As a result, a technology facilitator was required to attend all teleconferences so that problems could be fixed immediately (such as someone not understanding how to perform a particular operation, or a server going down and rerouting or notification was needed, or a team member using an old version of the technology). Finally, throughout the project, the team needed to devote effor t to its work practices since many of the initial practices did not work once the project got underway. Figure 3 depicts the differential effort required in these three areas of technology, strategy, and work practices over the course of the project.

Implications for Practice

Whether the objective be tactical in nature (i.e., reduction in costs and time, increase in quality) or strategic (i.e., increased flexibility, creation of new knowledge competencies), (VC.sup.3) teams will increasingly be favored in the search for orate renewal through shared destiny with other organizations. It is very likely that global and knowledge-intensive competition will make it imperative to pool the intellectual capital of employees across organizations and geographical distances, and that increasing time demands are making it difficult to do so through the traditional mode of face-to-face collocated teams. Organizations are turning to (VC.sup.3) teams to solve this paradox. Although every (VC.sup.3) team will take on a life of its own, there are some early warning signals that, if paid heed to, can ensure the success of the team (See the box: Early Warning Signs).

The success of such teams will require not just provision of technology but more importantly formulation of appropriate inter-organizational strategy and structuring of conducive inter-organizational work processes and dramatic reassessments of current business **contracts** , practices and processes. Further, all three--technology, strategy and work processes-- will have to be flexible enough to be molded to the requirements of each of these teams depending on their creative requirements.

Implications for Research

As with any case analysis, the generalizability of the results can only be assessed by observing future similar cases and by applying theory to understand the behavior patterns. Thus, the first implication of this study for future research is to encourage researchers of virtual teams to examine virtual teams varying in level of innovativeness. If these findings are supported in future research, they suggest that an important factor determining how knowledge is shared in virtual teams is the innovativeness of the team objectives: highly innovative teams are innovating in both process and product and thus their knowledge-sharing practices are likely to evolve over time. Identifying patterns in this evolution across cases will be an important first step toward creating a theory of knowledge-sharing in virtual teams.

This study offers another implication for research. As recently as 1999, DeSanctis and Monge reported that the literature suggests that "some tasks are performed less effectively when done electronically; for example: consensus formation" (p. 696). Later in their article, they state: "About the only consistent finding in the empirical literature with regard to task and media is that (the tasks of) thinking convergently, resolving conflict, or reaching consensus (are) better done face-to-face than electronically" (p. 697). Finally, they conclude: "exchanges involving knowledge-elicitation or sharing may more readily lend themselves to the virtual mode than those involving consensus formation....There is a great need for research that isolates the task conditions that are most effective in virtual settings" (p. 697). The SLICE case calls such statements into question. Clearly, the eight engineers were performing tasks that involved convergent thinking, conflict resolution, and consensus development--and managed to do so without the use of face-to-face. Why the difference between our findings and those in the extant literature? One explanation might be provided by DeSanctis and Monge when they point out that much of the research results described in the literature are based on studies of electronic mail and computer-conferencing systems, rather than the type of knowledge portal technology used in this case, as well as communications that use multiple media. In electronic mail, it may be harder to combine context and content, whereas combining portal technologies with voice allows for making authorship, documents, document histories, and team comments as well as context accessible to all participants simultaneously. Thus, one implication of this case is to suggest that task-media fit questions are not the right questions to ask at all--especially with highly innovative teams. In such teams, knowledge-sharing for purposes of informing others cannot be distinguished from consensus-building, since it is in the process o f consensus-building that knowledge is shared, and vice

versa. Thus, the research question is not one of predefining which tasks will work and won't work in virtual settings, but how tools, work processes, and group and organization structures can be designed to facilitate knowledge capture, dissemination, and synthesis under different task conditions.

Finally, the SLICE case clearly raised research questions about how to structure knowledge-management systems for radical innovation. The engineers never effectively resolved the issue despite working closely with the technology developer to produce 23 different technology versions during the 10 months of the team activity, and working closely with management to be permitted to make extraordinary modifications in the typical engineering work process. In the end, the team members never did use the tool's powerful navigation and search functionalities, nor did they ever document any but the most rudimentary context knowledge possible. For example, design rationale documents were never prepared; as a result, a team in the future will not find the 600-plus entries in the Notebook of much value. The team also never did resolve the issues of speedy knowledge retrieval. In the end, they recommended that (VC.sup.3) teams should consider establishing a role of a knowledge manager. Such a knowledge manager can serve several functions. First, the knowledge manager can ensure that valuable information is not left unrecorded in the knowledge repository by reviewing the roadmap of the repository and identifying obvious gaps in logic. For example, if explanations, circumstances, and constraints for quantitative estimates are missing from an entry (for example, the circumstances under which the impinging holes in a design would be too expensive), the knowledge manager could ask for more detail. Second, the knowledge manager can help to ensure that outsiders such as managers can review the entries in the information repository, by providing an easy way for others to get the informaticn they need. Finally, the knowledge manager can ensure that the team is able to make use of the documentation that they create by reminding the team of past information and helping them find it when needed.

This problem of how to design knowledge management systems for innovation has been recognized by other scholars as well. Boland et al. (1994) and Malhotra (2000) attribute this problem to the simplistic representation of knowledge management that an information-processing view promotes--a representation that objectifies information, presupposes a one-for-one mapping between words in an information system and objects or conditions in the worlds, and overlooks the fact that words are symbols whose meanings are always multiple and ambiguous. An alternative representation of knowledge management could be one proposed by the distributed cognition literature (Hutchins 1991; Resnick 1991). In this view, knowledge is not "shared" per se, but rather individual actors create an understanding of knowledge by acting and observing how others act on this knowledge. A knowledge management system designed to support distributed cognition would need to go beyond the functionality of a searchable knowledge repository. In addit ion, the system would need to provide an editable whitespace for easily capturing new ideas and blending idea generation with selection (Olson and Olson 1996). It would also need to allow automatic categorization of the knowledge, so that users need not presuppose a keyword hierarchy or organization of the knowledge. Finally, it would need to support the simultaneous display of multiple representations of knowledge--representations that are distinctive for different individuals as well as varied in level of detail (Boland et al. 1994). While the technology used by the SLICE team had some of these features (an editable workspace), it did not have all of them. Future research is required to determine to what degree these additional features will help to alleviate the knowledge management problems the team encountered. Given the team's success, maybe technology for knowledge management is less important than technology that allows knowledgeable people to collaborate.

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Realization of the virtual enterprise paradigm in the clothing industry through e-business technology

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ABSTRACT: This paper presents a methodology and a case study for supply chain management in the clothing industry that makes extensive use of the virtual enterprise paradigm. The main research goal was to design and implement a prototype e-business software component and carry out tests in several industrial users. The research effort resulted in the extended production data management system, which supported the business processes of customer order management, subcontractor selection, and multi-site/multi-firm production orders release. The enablers of this software application were business-to-business e-commerce technologies in the operating context of application service providers. [PUBLICATION ABSTRACT]

TEXT: REALIZATION OF THE VIRTUAL ENTERPRISE PARADIGM IN THE CLOTHING INDUSTRY THROUGH E-BUSINESS TECHNOLOGY*

This paper presents a methodology and a case study for supply chain management in the clothing industry that makes extensive use of the virtual enterprise paradigm. The main research goal was to design and implement a prototype e-business software component and carry out tests in several industrial users. The research effort resulted in the extended production data management system (EPMS), which supported the business processes of customer order management, subcontractor selection, and multi-site/multi-firm production orders release. The enablers of this software application were business-to-business (B2B) e-commerce technologies in the operating context of application service providers (ASPS).

(SUPPLY CHAIN MANAGEMENT; VIRTUAL ENTERPRISE; CLOTHING INDUSTRY; &BUSINESS TECHNOLOGIES)

1. Introduction

Today's global economy, enhanced and hastened by rapidly changing technologies of all types, is putting pressure on companies to increase the efficiencies of all their business processes (Davenport and Short 1990). Competition forces all firms to concentrate on "core competencies" while transforming themselves to participate in emerging inter-enterprise formations following the virtual/extended enterprise paradigm.

Like all major vertical sectors, the clothing industry has witnessed a boom of announcements of new business-to-business (B2B) exchanges over the last years. Retailers and manufacturers of all sizes have reacted to these innovative technologies, and many of them have embraced new business model visions with enthusiasm. Others have responded more cautiously, taking careful steps forward and looking more for an established solution rather than an opportunity to define one. In both cases, it has become clear that a leading edge communication system and a reengineered business model are crucial to the development of an extended clothing enterprise using

e-business technologies.

This paper presents a methodology and a case study for supply chain management in the clothing industry sector, which has pioneered if not invented the virtual/extended enterprise paradigm. The main research goal was to design and implement a prototype e-business software component and carry out tests in several pilot industrial users. After the construction of the AS-IS and TO-BE business models with the use of an enterprise modeling methodology, the research effort resulted in the extended production data management system (EPMS), which supported the reengineered business processes of customer order management, subcontractor selection, and multi-site/multi-firm production orders release. The enablers of this software application were B2B e-commerce technologies in the operating context of application service providers (ASPS). The reengineered business models were evaluated through the use of simulation and activity-based management (ABM).

This introduction is followed by a review of the emergence of virtual/extended enterprises in Section 2. A description of the objectives and the methodology used is given in Section 3, while Section 4 presents the case study. The implemented software systems are presented in Sections 5 and 6, and the conclusions are presented in Section 7.

2. Toward the Virtual/Extended Enterprise Paradigm In the beginning of the 1990s, the concept of virtual/extended enterprise emerged in the literature with strongly descriptive articles (e.g., Bensaou 1996; Loebbecke and Jelassi 1996; Sieber 1996) that present notions of a virtual organization. For example, Loebbecke and Jelassi (1996) claim that "the virtual organization concept aims at creating a customer/service oriented company, which overcomes geographical constraints, alleviates the traditional dichotomy between centralized and decentralized organization structures and processes." The term virtual organization (vo) has been widely used since Malone and Davidow published their book in 1992 (Davidow and Malone 1992). The first solid definition of this newly emerging production scheme was given in 1993 by Byrne (Byrne 1993), stating that a virtual organization can be defined as a temporary network of independent companies-suppliers, customers, and rivals linked by information technology (IT) to share skills, costs, and access to one another's market. This rather demanding and strict definition of the virtual organization through the years gave way to a more flexible one, which takes into account the problems that could emerge such as legal aspects and trust. Later, Jarillo (Jarillo 1995) argued against the company centric value chain of Porter (Porter 1995) in favor of a business system referring to the whole set of companies that are involved in the value adding process starting from the raw materials.

The problem statement of the virtual enterprise is "how can a whole business system be organized in a way that combines the advantages of vertical integration and the advantages of subcontracting." The clothing industry is the archetype of the virtual/extended enterprise, many years in advance of the emergence of the term in the international literature (Browne, Sackett, and Wortmann 1996). The Benetton story (Jarillo 1993) is a well-referenced example of success that can be attributed to the virtual/extended enterprise organization concept. Benetton, as well as many other clothing industries, is a vertically de-integrated company in all the activities that make up the business system: styling, design, manufacturing, logistics, distribution, and sales. They rely on external people and companies for the major part of these crucial activities.

Global manufacturing trends spell considerably increased competition among manufacturers in both developed and non-developed countries. The new information and communication technologies (ICT) and the processes of globalization have already changed the face of manufacturing (Sheehan 2000). Today, manufacturing exhibits the following characteristics:

* globalization, in the sense that a wide range of functions from Research & Development and marketing to distribution are now undertaken on an integrated global basis

* networking, meaning that the coordination of these functions makes intensive use of electronic networks and of virtual and geographical clusters of expertise
* mass customization, in that methods of production must allow for detailed customization of products to meet the needs of individual markets and customers

* digitization, in the sense that many of these processes are **controlled** by advanced computer systems, which limit the need for human intervention.

The most compelling example of a virtual/extended enterprise using e-business and Internet technology (B-webs according to Tapscott, Ticoll, and Lowy 2000) is undoubtedly cisco, which has designed, developed, and delivered a service to manage suppliers, business partners, and end customers (Cisco Connection Online, Tapscott, Ticoll, and Lowy 2000). Specifically, in the clothing industry, the most successful examples of companies operating as virtual enterprises can be met in certain u.s. high fashion apparel companies. They have kept only a small number of processes in-house: those identified as strategic and core competencies that support the overall coherence of the brand. Such companies like Ralph Lauren, Calvin Klein, or Donna Karan, having been unable to build on a locally embedded community of potential partners and subcontractors, decided to create networks their own way (Bonaparte, Cangemi, Lopez, and Pierantoni 1999). In doing so, they established a flexible membership framework in order to follow organizational needs and market transformations.
3. Objectives and Methodology

The objectives of our research project for the clothing industry were to apply newly emerged e-business technologies in order to improve the virtual/extended enterprise core business processes in terms of cost and lead time. A short description of the processes and the related objectives is given below.

CUSTOMER ORDER MANAGEMENT. This process accesses customer orders from the sales department, arranges product specifications, and assigns a delivery date. The reengineering effort was supported by the introduction of an electronic order management/workflow system.

SUBCONTRACTOR SELECTION. The clothing industry is characterized by networks of cooperating companies, each one specializing in different production stages. There is usually a primary **contractor** that collects customer orders and is responsible for transforming them to production orders. The latter are distributed to subcontractors who deliver final or semi-final products to the primary **contractor** . The subcontractor selection is a time- and cost-consuming process aiming at the best possible selection from a group of candidate firms. The project's objective was to improve this complicated process with the introduction of an Internet portal that would provide information on manufacturing skills and capacities of potential partners.

PRODUCTION ORDER RELEASE. This refers to the transformation of customer orders into production orders and their distribution to the selected subcontractors. The objectives of the project was to reengineer this time consuming process through the introduction of two rr solutions.

1. A software application for the electronic handling of production orders and their attached product and process specifications (technical data file).

2. A web-based software system responsible for the communication with the

subcontractors (technical data file transmission, subcontracted production monitoring).

The enterprise modeling methodology followed in this paper in order to model the above mentioned business processes was developed during a European research project (REALMS II-ESPRIT 23,357, Doumeingts et al. 1999). An overview of the methodology is depicted in Figure 1.

According to this approach, the first steps were the analysis and modeling of the existing system (AS-IS). The established IDEF-0 technique was used to model business processes and their activities, as well as the necessary resources to operate them. Raw data were obtained through interviews and meetings with the appropriate focus groups. The as-IS-is analysis phase aimed at identifying discontinuities within existing business processes and their specified intent. By discontinuities, we mean anything that prevented the process from achieving the desired results. In essence we identified symptoms of shortfalls and then tried to isolate root causes. Performance indicators such as lead times and cost were used as a basis of judging future improvements of the business processes.

FIGURE 1.

The design of the new system (TO-BE) started with the elaboration of both IDEF-0 and IDEF-3 diagrams and ended with runs of the simulation model of the future business processes. The presence of IDEF-3 diagrams was particularly helpful to the construction of the simulation model with ARENA. The design step was further enriched through the application of activity-based management (ABM) that complemented business process simulation by using its results in the analysis of processes to identify inefficiencies and non-value added activities. It dealt with effectively managing activities to yield continuous improvement by answering "why" and "how well" activities were adding value to products and services.

According to the requirements of the redesigned business processes, a software prototype of the new e-business system B2B was produced in order to examine its functionality through exhaustive testing in the pilot user's environment. This step led to frequent modifications of the prototype based on restrictions of standardized IT development tools. Therefore, the definition of the new system and the selection of the IT structure was done in iterative steps so as to achieve a solution that best fitted the newly designed system and fulfilled an economic implementation of the future IT structure. The IEEE/ANSI 830 standard was used for developing the software requirement specification (SRS) of the software product. The user implementation model was defined including the automation boundary of the system, the basic functions with input and output formats, communication interfaces, and manual support activities, as well as performance requirements and other system's operational constraints.

After the implementation of the solution, the last step of the methodology was the evaluation of the results achieved by the installation of the new B2B application. To assure comparability, the evaluation of the new system was based on the same performance indicators as the old one. The comparison led to conclusions concerning the added value of IT in supporting the selected business processes.

4. Case Study

Mass Fashion SA is the largest and more representative of the three pilot users that have participated in this research. The firm was established in 1976 and is located in Drama (northern Greece). At that time, it had an annual production of 100,000 T-shirts and 50 employees. Today, Mass Fashion has 250 employees and produces 2.5 million pieces, which are exported all over Europe. According to the 2001 ICAP report, Mass Fashion is one of the biggest T-shirt and sweatshirt producers in the Greek clothing industry.

Its customers include the biggest department stores, wholesalers, and catalogs. The company operates in a virtual enterprise environment, acting as a primary **contractor** for major European customers and using many permanent and temporary subcontractors both in the country and abroad. It does not own any shops, it does not sell to retailers, and it does not make any franchise agreements.

Mass Fashion SA mainly produces cotton garments for women such as T-shirts, blouses, tops, pants, skirts, dresses, and nightgowns. The target market group for the company is young people that prefer a casual dress code for their everyday needs. The competitors for this market mainly come from the Far-East region, and the strategic vision of the company is to improve the quality and to focus on more demanding consumer groups, where the competitors are difficult to approach.

The production phases of the final products are the following:

* Raw material purchasing

* Knitting

* Dyeing

* Cutting

* Sewing

* Quality **control** and packaging

A broad network of smaller enterprises is used to add value to the semi-final products and reduce the total costs. Figure 2 depicts the Mass Fashion's supply chain.

4.1. Analysis and Modeling of the Existing System

The project team conducted individual interviews with the employees involved in the customer order management and the subcontractor selection business processes. Additionally, meetings with focus groups took place in order to clarify the characteristics and requirements of each business process. This phase was supported by questionnaires and job descriptions for each employee who participated in handling customer or production orders. The objective of this analysis was to collect all the necessary data to be used in the next phase, which was the modeling of the existing system (AS-IS) using the men-0 method (Figure 3).

FIGURE 2.

This phase resulted in the recognition of weaknesses in the present situation that prevented the company from delivering the customer order at the promised time. The most critical weakness identified were long customer order data entry and process times, extensive market research times for subcontractor selection, and high resource costs. Another drawback was the fact that middle- and higher-level employees were devoting a considerable amount of their time in non-value-adding activities.

4.2. New System Model

4.2.1. MODEL OF THE NEW PROCESS. The design of the new reengineered business processes introducing the e-business system resulted in the elaboration of IDEF-0 and IDEF-3 diagrams. The IDEF-3 diagrams provided us with the ability to represent aspects of the process such as concurrent activity executing and alternative routing. These aspects enabled us to build the simulation model much easier.

4.2.2. SIMULATION. The simulation model was based on the following assumptions:

* The time between two successive order arrivals was exponentially distributed with a mean value of 2.06 h. This was based on past observations during four selling seasons (2 calendar years).

* Orders were entering the system either alone (60.3%), or in batches of two (24.7%) or three orders (15%).

FiGuRE 3.

TABLE 1
* The arriving orders were divided into three main categories: wholesaler orders (87%), department store orders (7%), and catalog orders (6%).

* The orders were categorized in nine different types (as shown in Table 1), depending on the way they enter the system (e-mail, bar code, or post). The last column of Table 1 shows the percentage of the occurrence of the different system entry types within each order category. For example, there are three types of incoming orders from department stores. Type 1 represents the 40% of the orders, which enter the system by e-mail; Type 2 represents the 50% of the orders, which enter the system by bar code; and Type 3 represents the rest 10% of the orders, which enter the system by post.

* There was a one-to-one relationship between the system servers and the employees.

* The server process times were normally distributed.

* Routing time between servers was negligible.

* The users worked 8 h/d. They stopped working in the end of each working day or week and they continued their work the next day or Monday if there was a weekend in between from the exact point they had stopped.

* The subcontracted selection process was performed with web-based reverse auctions. In the past this process was conducted manually.

* The subcontracted selection process followed the business rule depicted in Table 2. This rule was a result of the company's past experience and the duration of the subcontracted selection process was based on information collected from direct contacts with other members of the industry.

Based on the assumptions and the IDEF-3 diagram presented earlier, a simulation model of the new process was constructed. The simulation software used was ARENA 2.2 Enterprise Edition for MS Windows. The model ran for 63,360 h (60 selling seasons/30 calendar years) with a warm-up period of 5,000 h. The actual running time was 23 min on a Pentium III, 500-MHz computer.

The simulation results demonstrated a significant improvement in the lead-time from the customer order reception to the selection of the subcontractor. The decrease in lead times ranged between 41.5 (Order Type 9) and 67 h (Order Type 5). The results for the different order types are shown in Table 3. The measure of variability of the simulation output results is given by the information of the column labeled Half-Width Interval (95%). This information represents 95% confidence intervals calculated via the batch means approach (Kelton, Sadowski, and Sadowski 1998).

TABLE 2

TABLE 3

TABLE 4

Utilization data was also collected from the simulation. This information was important for the determination of the necessary number of employees needed in the reengineered process. 4.2.3. ACTIVITY-BASED MANAGEMENT. The simulation results combined with future cost estimations provided the necessary information for the development of an activity-based costing (ABC) study. The results of this study (in EURO per year) are summarized in Table 4.

Four cost categories were used for the calculation of the process costs. The calculations were carried out for both the AS-is and the TO-BE situation.
The ABC study results proved that the implementation of the new system would induce a decrease into the cost of the process. In particular, it was observed that a substantial decrease in the cost of carrying out the subcontractor selection activity would be realized. This cost reduction was due to the fact that the cost of equipment in the new process was estimated to be (by far) less than the one of the old process (less faxes, phones, and photocopies). Figure 4 shows a bar chart comparison of the AS-is and TO-BE cost per activity.

FIGURE 4.

FIGURE 5.

The costs of four out of the five activities (2-5) of the process were reduced in the reengineered situation.

Figure 5 provides a different view of the estimated cost after the introduction of the IT system by analyzing the different cost categories. It is worth stating that although the biggest absolute cost reduction came from the personnel category (EURO 49.251), the highest percentage of reduction was traced in the equipment category (68.51%).
4.2.4. EVALUATION OF SIMULATION AND ABM RESULTS. The simulation and ABm results justified the proposed design of the system. The evaluation was based on two crucial performance indicators:

* Total lead time (time period from the customer order reception to garment to shelf): the analysis of the process starting with customer order reception and ending with the subcontractor selection showed a decrease in lead time of approximately 1 week on average. It was assumed that this reduction reflected at least an equal amount of reduction for the whole process.

* Cost: the cost for carrying out the process starting with customer order reception and ending with the subcontractor selection showed a decrease of EURO 74.88.

5. Implementation of the EPMS Software

The EPMS software aimed at being a universal, transparent-access, Internet-based application. It consisted of two discrete submodules:

* A portal and supplier's electronic market for the clothing industry: this application aimed at being the information source for the whole Greek clothing sector by supporting the web-enabled tracking, selecting, and evaluating of qualified partners. The application's front end is an Internet site acting as a web **contractor** -subcontractor information pool.

* B2B System for production orders release: this module is responsible for technical file data management (CMS; product and process specifications attached to production orders) in an e-structured manner and for establishing an ongoing web monitoring of the B2B relationship.

Both systems, with the exception of the technical file data management submodule, were accessed remotely by the users. The pilot applications were hosted by an ASP (Advanced Services Group Ltd.) who was responsible for integrating software with hardware and networking technologies, providing IT maintenance, and consulting services in a 7 X 24 enterprise-class level. The EPmS application workflow is depicted in Figure 6.

Intercommunication between the two EPMS modules is achieved through the use of an intermediate application called capacity manager. This is a bridge application running on both submodules. On the portal's side, it is responsible for the management, successful retrieval, and exporting of the subcontractor capacity data in request. On the other side, it downloads and imports the data set into the capacity availability function of the 13213 submodule. After that, the capacity workload function is ready to calculate the subcontractor's potential loading and therefore can determine its ability to undertake the production order in demand. The application's workflow is depicted in Figure 7.

5.1. Portal and Suppliers' Electronic Market

The portal and supplier's electronic market is an integrated submodule that provides bilingual (Greek/English) information about Greek clothing industry issues and is empowered by a real-time help utility. It is based on a thin client/server Internet architecture, utilizing a three-tiered scaled structure on the server side: web server, application server/ web-database connectivity server, and relational database management system-RDBMS. This architecture offers the advantage of easy access to system users along with expandability and load balancing benefits to the system platform. This is achieved through the three tiers' physical separation and the Open DataBase Connectivity (ODBC) standard adoption that allows the migration of structured system data into any relational open architecture platform.

FIGURE 6.
FIGURE 7.

The system uses a star topology: the clients (browsers) are connected to the main server through internet service providers (isps) and backbone applications as intermediaries. The data packs are transferred with Tcp/IP-based protocols (such as Hi-rP, Hz-rps, and FTP), while in the local network level, other data transfer protocols are supported.

The system produces dynamic HTML pages, the appearance and the context of which depend on the database content and the user-submitted criteria. The module architecture is depicted in Figure 8.

5.2. B2B for Production Orders Release

This submodule of the application consists of two parts: the first one is responsible for technical data file management and is implemented at the local company database level, while the second handles the communication between the primary **contractor** and its subcontractors using e-business Internet technologies.

5.2.1. TDFMS
This subsystem supports the creation, editing, and handling of the technical data file by the primary **contractor** . The activities carried out by TDFs are shown in Figure 9. The technical data files contain all the necessary information for outsourced production (technical specifications, sketches, color and size sets, etc.). The application runs locally in cooperation to an materials requirements planning (MRP) application, which helps the **contractor** to calculate the necessary quantities to meet the promised customer orders.

5.2.2. B2B COMMUNICATION SYSTEM. This subsystem is responsible for the secure projection of the production orders with their technical data file to the Internet. Additionally, it monitors the production order progress. In doing so it uses three different functions:

* The order documentation function, which used by the subcontractors to upload and browse attached technical data files of production orders released by the prime **contractor** .

FIGURE 8.

FIGURE 9.

* The capacity and material **control** function, which is responsible for the subcontractor's work centers loading.

* The shop floor monitoring function, which is responsible for delivering a report to the primary **contractor** that includes:

* Production Process Information

* Early Start Date, Late Due Date Information

* Item Production Data

* Production Quality Feedback

The process model that contains the activities supported by the B2B communication system is depicted in Figure 10.

5.3. Evaluation of Implementation Results

In order to evaluate the results of the research undertaken, two performance indicators were utilized. These performance indicators were lead-time and cost of the business processes under consideration. The case company has been using the EpMS software for 3 mo to support the customer order management, subcontractor selection, and multi-firm production order release processes. The results of the new system application have already justified the company's decision to introduce these new technologies.

FIGURE 10.

More specifically, as far as lead-time is concerned, the simulation carried out in the design phase produced quite accurate estimates of the total lead-time reduction, which was approximately 1 week. Regarding the cost parameter, there were two dimensions that had to be considered: the personnel cost and the equipment used cost. The former ranged between the values estimated by simulation in the design phase. The latter however, exhibited a dramatic reduction in the actual value (sometimes up to 75%), which was bigger than the reduction estimated from the simulation runs.

The lessons learned from this project concerned mainly the level of automation and information technology penetration in the clothing industry. The inexperience of the companies' management on these new systems and their focus on the production technology processes left them behind the advances in electronic commerce and database technology. Before the emergence of the **virtual** enterprise production scheme, the **communication** needs were limited to trade data; thus, the volume of information **flow** was sufficient. However, with the emergence of the **virtual** enterprise concept, the clothing sector seems to be unready to adopt the new technology. In our research, we confronted subcontractors that did not respond positively to the new situation. This attitude had its roots in the culture of those companies, which was anything but IT oriented. In the Greek and Balkan clothing industry, the subcontractors are mostly small

family business (as small as three employees) without any computer skills. On the other hand, subcontractors of substantial size and adequate computer skills are often reluctant to share their capacity data throughout the virtual enterprise network.

The overall impression was that the information technology brought about a number of improvements in the operation of the case company. However the majority of the subcontractors seemed to be unprepared for efficiently adopting the new e-business technologies emerging in the industry.

6. Conclusions

The business relationships between clothing companies and distribution factories with complementary skills and manufacturing abilities become much closer and more important if they adopt new logistics, communication, and management techniques that rely on computer-integrated logistics, Internet, and quick-response e-business systems. As the delivery times between supplier and customer get shorter, the need for cooperation between dependent and independent clothing factories and their suppliers becomes more long-term in the form of the virtual enterprise.

The application of B2B e-commerce technologies enabled the company studied in this research to:

* Enhance monitoring of the partner network in the virtual enterprise

* Apply business process improvement regarding the business dialogue processes

* Reduce business transaction lead-time

* Increase flexibility and quick response to the market needs

* Improve resource management

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DESCRIPTORS: Supply chains; Clothing industry; Studies; Electronic commerce
CLASSIFICATION CODES: 9130 (CN=Experimental/Theoretical); 5250 (CN=Telecommunications systems & Internet communications); 5330 (CN=Inventory management); 8620 (CN=Textile & apparel industries)
PRINT MEDIA ID: 39493

...TEXT: of individual markets and customers

* digitization, in the sense that many of these processes are **controlled** by advanced computer systems, which limit the need for human intervention.

The most compelling example... of cooperating companies, each one specializing in different production stages. There is usually a primary **contractor** that collects customer orders and is responsible for transforming them to production orders. The latter are distributed to subcontractors who deliver final or semi-final products to the primary **contractor** . The subcontractor selection is a time- and cost-consuming process aiming at the best possible... wholesalers, and catalogs. The company operates in a virtual enterprise environment, acting as a primary **contractor** for major European customers and using many permanent and temporary subcontractors both in the country...

...of the final products are the following:

* Raw material purchasing

* Knitting

* Dyeing

* Cutting

* Sewing

* Quality **control** and packaging
A broad network of smaller enterprises is used to add value to the... qualified partners. The application's front end is an Internet site acting as a web **contractor** -subcontractor information pool.

* B2B System for production orders release: this module is responsible for technical...

... at the local company database level, while the second handles the communication between the primary **contractor** and its subcontractors using e-business Internet technologies.

5.2.1. TDFMS

This subsystem supports the creation, editing, and handling of the technical data file by the primary **contractor** . The activities carried out by TDFs are shown in Figure 9. The technical data files...

... application runs locally in cooperation to an materials requirements planning (MRP) application, which helps the **contractor** to calculate the necessary quantities to meet the promised customer orders.

5.2.2. B2B... to upload and browse attached technical data files of production orders released by the prime **contractor** .

FIGURE 8.

FIGURE 9.

* The capacity and material **control** function, which is responsible for the subcontractor's work centers loading.

* The shop floor monitoring function, which is responsible for delivering a report to the primary **contractor** that includes:

* Production Process Information

* Early Start Date, Late Due Date Information

* Item Production Data...

...them behind the advances in electronic commerce and database technology. Before the emergence of the **virtual** enterprise production scheme, the **communication** needs were limited to trade data; thus, the volume of information **flow** was sufficient. However, with the emergence of the **virtual** enterprise concept, the clothing sector seems to be unready to adopt the new technology. In...

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ABSTRACT: This paper presents a qualitative study of the integration of supply chain management and business process management activities. It reviews published literature in both fields and a number of supporting areas, revealing a minimal overlap in the research. A number of case studies of progressive organisations are examined, including an in-depth study of Nortel Networks Corporation's recent market repositioning and current supply chain integration activities. The study concludes that, while there is little evidence of research exploring the integration of processes extending throughout supply chains, some businesses are gaining competitive advantage by maximising the efficiency of their global supply chains or **virtual** organisations. A conceptual **model** of an integrated **business** process, derived from the case study, is presented, which highlights the importance of communication between processes and between partners in the supply chain.

TEXT: Keywords Process management, Supply-chain management, Model, Integration, Globalization

Abstract This paper presents a qualitative study of the integration of supply chain management and business process management activities. It reviews published literature in both fields and a number of supporting areas, revealing a minimal overlap in the research. A number of case studies of progressive organisations are examined, including an in-depth study of Nortel Networks Corporation's recent market repositioning and current supply chain integration activities. The study concludes that, while there is little evidence of research exploring the integration of processes extending throughout supply chains, some businesses are gaining competitive advantage by maximising the efficiency of their "global" supply chains or " **virtual** " organisations. A conceptual **model** of an integrated **business** process, derived from the case study, is presented, which highlights the importance of communication between processes and between partners in the supply chain.

Introduction

In today's highly competitive world successful businesses need to "reinvent" themselves almost continuously. Global deregulation in many industries is opening markets to the entry of new competitors. Corporate expansion and a developing global culture are driving standardisation of business practices and a reliance on co-operation between customers, suppliers and other partners. How do organisations become more responsive, more efficient, and achieve coordination of the supply chain? How can the benefits of quality process based management be extended to embrace all members of the supply chain?

During the 1990s researchers and practitioners began to view the supply chain as a whole, and promoted customer focus, supplier partnerships, cooperation and information sharing and business process management (Hamel and Prahalad, 1989; Christopher, 1992, 1999; Lee and Dale, 1998). However, the integration of research and practice in customer supply chain and business process management has not been evident. Process management has been about improving the linkages between internal processes and supply chain management has been about improving the linkages between firms. As "virtual" organisations develop, business leaders need to take a holistic approach and consider the whole supply chain as one business.

This study suggests an approach for managers involved in global business. Can effective management of business processes deliver greater benefits by integrating processes that extend throughout the supply chain? Can lessons be learned from the experience of organisations that operate in successful global supply chains? To address this question, this study sets out to understand the underlying relationship between managing business processes and managing supply chains.

Process based management approaches

Business process management (BPM) is considered to be a more general approach to organisational improvement. Zairi (1997) defines BPM as:

... a structured approach to analyse and continually improve fundamental activities such as manufacturing, marketing, communications and other major elements of a company's operation.

This seems to be an internalised view, and stresses the continuous improvement aspect of BPM. Elzinga et al. (1995) suggest a procedural approach to BPM and define it as:

A systematic, structured approach to analyse, improve, **control** , and manage processes with the aim of improving the quality of products and services.

De Toro and McCabe (1997) stress the cross-functional nature of process management and highlight the need for empowered employees to have "the authority to examine, challenge and change work methods". Empowerment has long been one of the stumbling blocks of process-focused management. Many employees are uncomfortable with "empowerment", and many managers are reluctant to relinquish their traditional **control** .

Following an analysis of the BPM literature, Lee and Dale (1998) conclude that most definitions of BPM agree that it is:

Structured, analytical, cross-functional and a continuous improvement of processes.

They go on to state that BPM integrates "the use of improvement tools such as re-engineering, continuous improvement and benchmarking". McKay and Radnor (1998) point out that many organisations develop their own approach to managing business processes:

The common theme to the methodologies is that processes are chosen, process maps created, problem or non-value-added areas identified, solutions created, process redesigned and, then, implemented.

However, business management and process improvement is not a "one-off" activity, but should be treated as a "plan, do, check, act" cycle. The path to business improvement must be an ongoing series of radical adjustments; each followed by an assessment and a refinement to supporting processes. Business process management cannot be about a short-term improvement, and should not be about a gradual improvement. To maintain leadership in a fast changing world, a world class organisation must continually reinvent itself (Sethi and King, 1998).

The success of BPM depends on the strength of the key organisational drivers which create the impetus for change (Peppard and Rowland, 1995). Armistead et al. (1997) identify five factors as the main drivers of process change:

(1) globalisation;

(2) changing technology;

(3) regulation;
(4) the action of stakeholders; and

(5) the eroding of business boundaries.

A recent survey of Northern Ireland's Top 100" companies (Hill and Collins, 1998) offered three states of competitiveness which drive managers towards considering process improvement methods:

(1) a company in crisis;

(2) a company in a strong competitive position, but envisaging greater competition in the future; and

(3) a company in a strong position, and wanting to capitalise on that position.

This survey indicated that the threat of future competition was stated by nearly half of the respondents as the main reason for redesigning business processes, while less than 10 percent claimed that "crisis" was a driver. These findings support the view of Ryan (1994):

Few companies are so well run that they cannot enjoy the benefits of reinvention.

Enablers of and barriers to business process initiatives

Information technology was originally put forward as the key enabler in process re-engineering projects. Davenport and Short (1990) advocated "using the power of modern information technology to radically redesign business processes in order to achieve dramatic improvement in performance". A more intrinsic enabler for operating a successful process based organisation is communication. During the last decade communication technology has grown alongside computer technology, and enables the necessary flow of information between functions, and between supply chain partners. Corrigan (1996) noted that many companies studied "highlighted the protectionism that existed at all levels, and how the positiveness of the political climate was very important in introducing change". Human resources management is crucial to the success of radical process change initiatives. As traditional power structures are eroded and roles change, employees need support and help to understand their positions in the new structure.

The enablers of process improvements across supply chains can be expected to be largely the same as those within companies. The goals of the process are not necessarily the goals of individual companies, but in each case the value expected by the customer must be communicated to all people involved in the process. Establishing a culture of TQM and flexibility in each member of a supply chain is essential to enable seamless integration of the overall business process. An example of this is Motorola who expect all their US suppliers to apply for the Baldrige National Quality Award.

Supply chain integration

Since the mid 1980's it has been observed that many successful organisations are co-operating with partners in their supply chains (Porter, 1987). This cooperation and the related "outsourcing" of non-core competencies (Hamel and Prahalad, 1989) have created inter-organisational networks. Benetton, for example, are able to respond to rapidly changing customer demands, particularly seasonal changes in fashion colours, by co-ordinating their own activities and their suppliers' activities (Christopher, 1992). Toyota pioneered "lean production" and "just in time" principles by encouraging suppliers to operate near by, and monitor stock levels directly (direct line replacement). This innovation allows rapid response to changing customer demands, and eliminated the cost of holding "just-in-case" stock. Christopher (1992) defines supply-chain management as "the requirement to extend the logic of (logistics) integration outside the boundaries of the firm to include suppliers and customers".

Cooper et al. (1997) go further and define supply-chain management as a philosophy for integrating all the activities in the life of a product or a service from the earliest source of raw materials to the ultimate customer,

and beyond to disposal. They suggest that this value system is best represented by a "value tree" where the "firm" is represented by the trunk, the branches represent multiple suppliers and the roots multiple customers. Any given path through the tree defines a particular "supply chain". Customer focus is an integral part of the supply chain philosophy. Every part of the supply chain must have the same mission: to satisfy the final customer and to maximise the value added by the overall chain. This implies a change in the traditional power structure seen in organisations. The most powerful employees are those in direct contact with the final customer. This inverts the traditional organisational structure (Doyle, 1994).

Integrating the supply chain

The concept of integration within the functions of a firm can be represented by Porter's "value chain" (Porter, 1987) (Figure 1). Porter looked at the firm as a collection of key functional activities that could be separated and identified as primary activities (inbound logistics, operations, outbound logistics, marketing and sales, and service) or support activities (infrastructure, human resource management, technology development, and procurement). He arranged these activities in the "value chain". Maximising the linkages between the activities maximises the efficiency of the firm and so the margin available for increasing competitive advantage or for adding shareholder value.

According to Doyle (1998):

A well-organized supply chain leads to increased efficiencies, faster response to market changes, better design and manufacturing processes, and increased productivity.

These approaches are similar to those of BPM as suggested by Lee and Dale (1998) and Peppard and Rowland (1995) where "supply chain" can be used inter-changeably with business processes. Furthermore, Figure 1 conveys the idea of processes spanning functions, as is the case for BPM (Sethi and King, 1998). Integration occurs between the primary activities in each value chain, and is enabled by the support activities. It also takes place between activities in different companies. In some cases, the support activities also share resources.
Changing company structures

Perhaps the most common organisation structure today is the matrix formation, which is a compromise between functional focus and product (or customer) focus. Members communicate through peers in the same function or peers in the same product line. As organisations continue to build global supply chains this trend towards informal communication structures will inevitably increase. This approach is an integral part of supply chain integration. To enable effective integration of the primary activities in the value chain, employees must be able to talk directly to their peers in other activities. To integrate various companies in the supply chain an equivalent communication must be created between activities in different organisations. Communication is between members of the same business process, not the same function or location (Armistead, 1996).

Figure 1

Small companies are inherently flat in their structures. Each employee is multi-skilled and may carry a project from inception to completion. This enables fast reaction to market changes and flexibility. Large organisations are generally slow to change, and often slow to even see the need for change. Integrating the activities of key parts of the value system will allow large virtual organisations to be more agile and gain competitive advantage in a fast moving market place. By empowering all employees in the supply chain, utilising world-class electronic communication systems and operating common simplified processes, even the

largest organisations can compete in this environment (Hamel and Prahalad, 1989; Lee and Dale, 1998).

Difficulties in extending the supply chain

As supply chains develop, they increase in complexity. The number of linkages to be managed increases and communication of a common goal becomes more difficult. Supply chain members become more dependent on each other. This dependency can cause feelings of insecurity in managers who feel that they are no longer in **control** of their firm's destiny. Also, the unique differentiating culture of particular organisations may be lost in the "oneness" of the supply chain. "Lean" management of inventory is critical, as buffers between activities, while individually small, add up to a significant inventory in the whole network. Another observed phenomenon of large supply networks is the "Forrester effect" or the "Bull Whip effect" (Lee, 1999). The communication of customer demand through the supply chain can be exaggerated at each linkage and distorted until supply is greater than the actual demand. This happened in the semiconductor industry in 1995. There was a perception that demand for semiconductors would be high, and distributors ordered up to three times what they actually needed. Suppliers scrambled to meet perceived demand only to find that poor information had left them with high stock levels.

Global business

The effects of a company seeking globalisation are far reaching. Managing the "supply chain" becomes a key focus as international operations must be able to source equivalent supplies anywhere in the world. Motwani et al. (1998) believe that global supply chain management "allows corporations to take advantage of diversity in the international environment by recognising and exploiting regional differences". Business information, including order details, inventory levels, directives and product changes, must be communicated to the people who need it, when they need it, wherever they are. Similar arguments are advanced in applying systematic measurement to BPM (Armistead, 1996). Moss Kanter and Dretler (1998) present a different view, suggesting that global strategy is synonymous with holistic approaches. They believe that "global" is an attitude rather than a geographic statement:

Global strategy involves thinking in an integrated way about all aspects of a business - its suppliers, production sites, markets and competition.

This approach considers all activity centres in the supply chain as one entity, not just looking at bits of it. It involves understanding and accommodating local variations and cultures, striving for open "world" standards and understanding international issues. All this needs to be part of the process and product design of the organisation (Lee and Dale, 1999), not added as an afterthought when seeking entry into a new market. A good example of a global attitude is at Ford Motor Company. Their "global car" concept consists of a basic engineering design, accompanied by regional variations to suit local tastes. Final assembly of models is postponed where possible to react effectively to local demands.

Literature consensus

From the brief summarised review of the literature, several key criteria are identified for a comparative analysis of business case data. These are total quality culture, process focus, supply chain focus, management commitment and performance outcomes. These criteria are not exhaustive; they are the more prominent themes in the literature. Total quality culture includes training, teamwork and collaborative people management. It implies some form of **control** measurement and an awareness of the wider business environment. Furthermore, the term implies an integration of TQ principles into normal operations (Dale, 1999). Process focus describes an

organisation's flexibility, agility and openness of communication. Peppard and Rowland (1995) see this criterion as a key test of an organisation's resolve for implementing BPM. Supply chain focus describes the involvement in a wider community of partners, customers, service providers and suppliers. Motwani et al. (1998) argue that organisations can only adopt a supply chain focus when other internal processes have been identified and improved. In the literature the two topics, process and supply chain focus, are normally treated separately although there is a degree of overlap in process and supply chain discussions. This suggests that integration of the two topics is inevitable, but as yet, researchers have only briefly mentioned that processes may extend outside the organisation (Tinnila, 1995; Van Hoek, 1998)

A number of writers (Armistead et al., 1997; Hamel and Prahalad, 1989; Dale, 1999) have noted management commitment, or leadership, as the most important driver for successful change. In BPM and supply chain it is therefore important to consider performance and measurable success which are very important in practice. Therefore, there must be a mechanism to differentiate "successful" and "unsuccessful" strategic decisions. Both Peppard and Rowland (1995) and Cooper et al. (1997) stress the importance of measuring performance outcomes.

Research methodology

Most of the research in the field of business process focused management and supply chain management has been by empirical observation and case study. A number of surveys of businesses in local regions have also been undertaken, notably Hill and Collins (1998) in Northern Ireland and Tikkanen and Polonen (1996) in Finland. Much of the development of methods, guidelines and "best-- practice" in this rapidly changing field is originating from inspirational "gurus" and management consultants, working with pioneering organisations like Nortel Networks Corporation, Ford Motor Company, Hewlett-Packard, and Rank Xerox.

This study uses a grounded theory case study approach (Glaser and Strauss, 1967) to discover relevant criteria that describe the behaviour of supply chain management in a process-focused business. Three case studies were analysed to determine the key criteria (Eisenhardt, 1989), in addition to those supported by the literature, for the main case study analysis. Eisenhart (1989) describes how the process of "grounded theory" starts with no overriding theoretical framework, but rather key criteria are developed as a study of an organisation grows. The study methods used in this study, as recommended by Eisenhardt, included the literature, ethnography, semi-structured interviews and archive material. The three companies involved were:

* Boeing A&T - Malcolm Baldrige National Quality Award Winner, 1998.

* Design to Distribution (D2D) Ltd - Towards **Contract** Manufacturing.

* Ford Motor Co. - Ford 2000 (The global car).

The grounded theory derived criteria were then used to analyse the main case study - Nortel - and inductively generate a conceptual model for an integrated business process.

Thus, complex case study data was analysed (Easterby-Smith et al., 1993) using semi-structured interview data (management and employees), transcripts, ethnographic observations, current and archived company information. The purpose of this research study is to look for the application of process management techniques between members of supply chains, and to understand ways to integrate core business processes. The in- depth case is of the new business model being created at Nortel Networks Corporation, a global communications technology provider. It

highlights what is believed to be "best practice" in the areas of supply chain integration, business process focused management, and a holistic approach to business operation.

Case studies

The organisations selected for analysis in these case studies are from a range of business sectors, and vary in size. The common factor is that they have all implemented some degree of process-focused change initiative and quality management system in the effort to become "best-in-class". Each case was analysed from the same viewpoint and summarised in the same format. This allows comparative case analysis of their structures, activities, and experiences. The three companies in these case studies are all striving to maximise their competitive position, and their internal efficiency. All three companies have embraced some formalised model of total quality management for day-to-day operations. Achieving accreditation from a recognised quality association is clearly a factor in improving competitive positioning, but the discipline of following a defined model is also integral to managing the organisation towards a common goal.

Each company determined a set of "core" processes and corresponding subprocesses, and mapped these to show how they affect the business. Integration of core processes was clearly mentioned in the Boeing and A&T cases, but integration and extension of these processes outside the organisation is not specified. Senior management is very clearly attributed with directing the change processes, and has demonstrated considerable commitment to the work. In the Boeing, D2D and A&T cases, senior executives managed much of the ongoing detailed supply chain relationships. Ford Motor Company clearly stresses the involvement of many supply chain partners to the operation. This is a tendency observed in the automotive industry as a whole. The other case companies have embraced customer focus and immediate supplier management approaches.

Overall a set of key criteria were identified (in addition to, and in support of, the literature):

* market changes;

* network strategy;

* total quality culture;

* process focus and supply chain integration;
* management commitment; and

* performance outcomes.

In-depth case study organisation - Nortel Introduction and sources of information

This case study looks at the strategic positioning of Nortel Networks Corporation as the global telecommunications business undergoes dramatic change. The corporation has responded to the new environment with several major strategic innovations, including:

* to create and dominate a new industrial sector;

* to operate a large organisation as if it were a small business;

* to **control** the complete global supply chain;

* to align the global operations of the company.

The research for this case study has come from interviews with members of

the global supply chain team, other Nortel Networks employees, current and archive company data and information.

Nortel Networks background

Nortel Networks has been a multinational corporation for many years. It is one of the five main telecommunications equipment providers in the world, and was named as the "World's Most Global Company" in its sector by the editors of Global Finance magazine in 1998. The corporation is North American based (US/Canada) with sales and manufacturing facilities scattered internationally. The traditional customers of telecommunications equipment were large national "postal, telephone and telegraph" monopolies (PTTs) like GPO/British Telecom. The equipment produced is very high quality and very expensive, but has traditionally had a long operating life. Research and development is expected to be slow and costly. The facility at Monkstown, Northern Ireland has developed into Nortel's main producer of switching and signal transport equipment outside North America. European and world sales are conducted from the European headquarters outside London. The case study is discussed under the criteria headings identified earlier.

Market changes
The global telecommunications market place is currently changing rapidly. Since the 1980s deregulation of the industry in most of the world has enabled a host of new companies to set up in competition to the traditional PTTs. These companies have new demands, new ideas and no legacy systems. They tend to be small, inexperienced in telecommunications and funded by investment capital. In the past few years the growth of the Internet and the blurring of the traditional line between data communications and voice communications has further accelerated this change and led to the creation of even more new customers. Computer networks use the telephone system for remote connections and computer users place telephone calls and video links across their computer networks.

The host of new customers has provided the opportunity for new entrants to the equipment manufacturing industry. Many of these new competitors are relatively small companies from the data networking business (e.g. 3COM and Cisco Systems) and are experienced in operating in a fast changing environment. The traditional legacy links between PTTs and national suppliers are disintegrating. New suppliers, and new customers create new technologies, shorter product life-cycles and the demand for quicker payback on investments. Developments are progressing in "web time", where technologies are being outdated in months rather than years. Nortel Networks' management terms this environment as the "short, short" business - short development times, and short operating lives. The existing PTTs are also reacting and are moving into international markets as secondary players. Telecommunications companies who operate in several countries want a supplier who can provide for their needs in each of these locations. This is the driving force for globalisation for any organisation which wants to operate in the world communications market.

Nortel Networks strategy

One approach is to accelerate the merging of data and voice communications networks and position Nortel Networks as the most responsive and most accessible supplier. In 1998, US$9.6 billion were invested in buying Bay Networks, one of the largest mission critical data networking companies in the USA. This created considerable turbulence in the stock market, but positioned Nortel as the one company capable of bridging the gap between the two industries. A world-wide restructuring is currently under way to present the new product, the "Unified Network" and the new merged organisation, "Nortel Networks" as global brands. The company is continuing to acquire smaller businesses, with reputations in the data market, leading edge products, or highly skilled employees, and is merging them into one

integrated customer-- facing organisation. This means constantly changing the business model rather than forcing new employees and business units into a rigid "one right way.

The "Manufacturing 2000" initiative involves rationalising the company's many manufacturing plants into a number of key supply chain centres and a set of globally interconnected supply and logistics operations. Each of these "systems houses" owns the supply chain for a given range of products, and has the responsibility to manage all activities from initial customer interest to customer satisfaction.

Nortel - Manufacturing 2000 - a regional experience

Strategic overview

As the corporate strategy began to emerge, a decision was made to rationalise manufacturing operations globally. There were 23 manufacturing sites around the world and, it was announced, John Roth expected that no more than seven should be needed. The main locations began to prepare themselves for whatever the new structure would be, and to position themselves as the preferred "systems house" in their market region. This created considerable unrest among employees, as it was expected that headcount would be reduced. In the first quarter of 1999, Nortel Networks' operation in Monkstown, Northern Ireland was selected as the main "systems house" for Europe, responsible for all transmission and switching equipment.

Total quality culture

Nortel Networks' operation in Monkstown, Northern Ireland has been using a process-focused, self-assessment quality system, based on the EFQM model, and before that had achieved ISO 9000 accreditation for manufacturing and information systems development. This created a regular performance measurement system, and helped to highlight and improve process performance issues. Nortel Networks have since won the Northern Ireland and the UK quality awards based on the EFQM principles, and a number of internal "best quality site" awards. Supply chain performance is being measured by a "scorecard" system. This encompasses measures of the financial organisation, end-to-end supply chain processes, customers and future growth. The key metrics and the aspects of the business measured are outlined in Figure 2.

The total quality culture approach involves team working and investing in people. Employees are encouraged to work in different roles and crossfunctional improvement teams.
Process focus and supply chain integration

As a systems house", Monkstown is responsible for the entire supply chain. The corporation recognised that in the global business it was not a case of companies competing, but supply chains. Nortel needed to make the most efficient use of the supply chain, and ensure that all business processes were aligned. In the words of Christopher (1999):

There will be advantage to be gained through the pro-active leadership of the supply chain network - in effect by the assumption of the role of supply chain "captain".

There is a significant paradox in the various views of supply chain and process integration. The supply chain is seen as a value chain adding value to a product from the earliest suppliers to the final customers. The core processes of an integrated business are seen as a flow of information and activity from customer interest to customer fulfilment (Figure 3). Suppliers, manufacturing operations and support functions are often offset as non-core activities. Nortel Networks' process management teams addressed

of Logistics Management, 1995) was limited to an indication of the growth of postponement applications in recent years. In the survey, over 50 per cent of respondents from the USA and Europe indicated that they now used postponement more often than five years previously. The data did not indicate where in the supply chain postponement was applied, which factors influence the growth of postponement, or what benefits were experienced.

Our survey was developed to assess the importance of ICT, market and operating circumstances on the application of postponement throughout the entire supply chain. Ideas were drawn from previous studies and the questionnaire was pre-tested in 16 interviews with managers in the automotive supply, electronics, food and clothing industries. Of the 533 companies in these industries that received a mailed questionnaire, 80 responded (15 per cent) after one call-back and a second mailing. Companies were selected from a company database based on their status as manufacturers and involved in international markets (importing and exporting). International markets tend to favour postponement applications that go beyond packaging only (see cases in Cooper, 1993; Lee et al., 1993). The four industries were selected because of the likelihood of providing a balance between industries where postponement is extensively applied (electronics and automotive) and industries where it is less extensively applied (food and clothing). Pre-test interviews confirmed this balance.

Results

In order to assess the extent to which companies apply postponement, respondents were asked to specify, for various activities along the supply chain, the share of goods tailored to customer orders. Findings indicated that there are differences in the application along the chain. Downstream activities such as distribution and packaging are largely postponed (56.93 per cent of flow of goods and 53.95 per cent). Upstream activities such as engineering and purchasing are postponed to a lesser extent (37.49 per cent of the flow of goods and 37.42 per cent). Overall however, the findings indicate that postponement is applied at multiple points in the chain and to a significantly high share of the flow of goods.

Table I represents the items used in developing multi-item constructs that measure the factors identified in the hypothesis. Constructs contain a minimum of two and a maximum of six items with a reliability of 0.67 minimum and 0.89 maximum. Postponement was measured throughout the supply chain, from engineering, through purchasing and manufacturing to distribution. Respondents were asked to specify the share of the goods flow on which these postponement applications are used The construct for postponement measures the application of postponement along the supply chain, from engineering and purchasing all the way down the chain to packaging and distribution. The other items were measured using seven-point Likert scales from 0 (not applicable at all) to 7 (very much applicable).

Figure 1 graphically displays the model which was developed using these constructs. The model uses the application of postponement as the dependent variable, because the objective is to explain the implementation of postponement according to the various factors that drive or facilitate its implementation.

The external application of ICT is operationalized using measures for upstream integration with suppliers and downstream integration with logistics service suppliers and customers. As hypothesized the construct was found to be related positively to the application of postponement. As expected, the implementation of postponement is facilitated when manufacturers are electronically linked to both customers and suppliers. A well-known example of how linking suppliers and the manufacturer to the customer can facilitate responsiveness if Benetton. This company uses point of sale scanner data in ordering products and in the planning of production

and replenishment of goods in the store.

The internal usage of ICT is operationalized using a measure of ICT application between in-house functions and in-house production plants. Surprisingly, the internal application of ICT was found to be negatively related to the implementation of postponement. The negative relation suggests that manufacturers should concentrate on linking production externally (to customers) when preparing for postponement.

Two constructs were used to measure the market dynamics, one dealing with variability in demand and one for dealing with changes in competition and production. The first contains demand-related items and not surprisingly it was found to relate positively to the application of postponement. The need for responsiveness to dynamic markets is an important driver of postponement applications.

More surprising was the negative relation found between the second construct for the operating environment and the application of postponement. This construct contains production- and competition-related items. Apparently, these considerations disfavour postponement at present; this finding may indicate that product, production technology and marketing policies are not facilitating, or are not equipped for, postponement even though markets are demanding the application of postponement through the supply chain.

Relevant operational characteristics for the implementation of postponement are the complexity of final manufacturing (operationalized using measures for technological complexity, capital and knowledge intensity) and the modularity and commonality of the product design. As expected, they were both found to favour postponement. Less relevant for the implementation of postponement is the increase of product variety during the final manufacturing or packaging of products: as expected, this element of the operating characteristics was not found to be highly rated while the use of manufacturing activities (further upstream in the chain) for customizing products, was found to relate positively to the application of postponement.

Table II lists the correlation coefficients for the constructs and the significance of the relations. All individual relations are significant, as well as the overall model (1 per cent level). Most importantly, the model explains 57 per cent of the variance, meaning that the application of postponement is explained in almost 60 per cent of all cases by the constructs used.

In connection with the findings that the production and marketing organization may not yet favour postponement, it was felt the SMART car provided an interesting example of a company attempting to prepare the operations in the supply chain for customization and extensive outsourcing, using information integration. The case presented in the next section may thus provide further insights into "how to make it happen".

The SMART car

Mercedes-Benz and SMH (Swatch) was expected to introduce a new vehicle concept, named SMART in late 1998. The car has been described as a new mobility concept aimed at reducing environmental damages caused by present traffic while satisfying individual mobility requirements. The conceptualisation goes beyond the actual car, and also embraces space saving parking concepts, networking with public transport systems and pool leasing. The car is a two-seater mini car (smaller than the Fiat 500), and has been developed mainly for in-city use. Both the car itself and the processes needed for producing and distributing the car to the final customer are focused on increasing the responsiveness to customer demands as much as possible. In general three stages in the supply chain are

involved in achieving customization.

First, the generic car is assembled in the plant in Hambach in Elzas-Lothringen in France (referred to as SMART Ville). The car is based on an integral body-frame (called "Tridion") to which modules are attached/ assembled. The car consists of five main modules; the platform, the powertrain, the doors and roof, the electronics and the cockpit, containing sub-modules and components. The modules are supplied in sequence for final assembly by a small number of first tier suppliers of which seven are fully integrated into the final assembly plant. These seven companies are located at the same site as MCC and supply "super modules" based on a postponed purchasing approach. Modules are bought by the OEM only when they are needed in the final assembly process (postponed purchasing). For example a complete rear section, including wheels, suspension and engine, is pre-assembled by one supplier who maintains the module in its possession until it is needed on the assembly line. The same is true for the doors and for the dashboard system. Together these seven suppliers supply 50 per cent of the total value of the purchased product.

In order to enable a smooth flow of goods within the plant, the car is moved along the work stations of the assembly line, which has a lay-out in the form of a cross. In this way, the "integrated suppliers" are able to supply their finished products directly into the final assembly line from their workshop adjacent to the factory. The effect of this enlarged role for the "super module" suppliers is that MCC will be able to assemble the car in 4.5 hours. Apart from short lead-times the benefits of this product design and flexible manufacturing system are that at a module-level components can be combined into a wide variety of finished products.

Other activities, traditionally considered as the core activities of a car manufacturer, such as the pressing of body-parts and the painting process and even the co-ordination of internal logistics, will not be performed by MCC. Not only is there a close participation of the suppliers in the final assembly of the car, but the suppliers are also strongly involved in the development, planning and launching of the product. What can be said about the outsourcing of components and modules manufacturing is also true for supporting services such as transportation, the ownership and maintenance of the production buildings and general site management.

It is planned that the car will be sold at locations such as shopping centres and other highly frequented places in urban areas through franchised organizations. These will use multi-media systems to enable clients to "build" their car in the showroom and for forwarding the order for the car to the distribution centres. The customer can thus be involved in the design process and sales can become more consultative, based on a direct dialogue with individual customers. It is anticipated that five interregional distribution centres in Europe will supply the dealer with the requested car within an order-to-delivery lead time of less than one day. Some of the final assembling tasks, like adding special features or light final assembly will be performed at the distribution centres (i.e. postponed manufacturing). In order to perform final finishing, the distribution centre will store the appropriate components.

Finally, the modular concept of the car enables the customer completely to renew and upgrade the product during its lifetime, based on the addition of product-features and the rapid replacing of body-parts As a result the car will be more of a consumption product than a fixed capital good and can have an extendable life.

The challenges of virtual integration

The SMART case illustrates the application of postponement at multiple points in the supply chain, in this case involving extensive outsourcing and sub- **contracting** . In the SMART case a high degree of integration is

achieved through the joint involvement of suppliers, distributors and the manufacturer in producing and delivering the car. Suppliers are taking over part of the assembly factory and distributors are performing final manufacturing, while sales outlets are involving customers in the "tailoring" of cars interactively and to their specific requirements. Integration is thus a cross-functional and cross-company phenomenon. Figure 2 graphically describes the process: notable is the extent to which the OEM/manufacturer is "squeezed out" of the physical flow of goods, as a result of the extensive involvement of suppliers and distributors.

MCC, the OEM in this case, maintains **control** over the supply chain by **controlling** and integrating the flow of information. They inform suppliers about orders, develop customer know-how by using POS-data and dialogue with customers about products and customer specific demands. Furthermore, they co-ordinate the manufacturing and logistics operations between the various parties involved and their operational style is akin to that of project management, with the delivery of a customized car as the project In line with the reasoning of Rayport and Sviokla (1995) the rich interaction between the flow of information and the flow of goods enables the creation of new products and services, in particular the mass customization of products. What can also be expected is that the chosen form of virtual integration will impact on the type of manufacturing, the approach to logistics, the form of communications, the type of performance measurement, and various other operational characteristics. Table III lists a set of changes observed in the supply chains studied in the survey and the SMART case, for the various functional areas along the supply chain, including logistics. These are supplemented with expected managerial challenges in the years to come.

The contribution of this paper is to confirm that postponement does have an operating basis, applicable along the supply chain, with the aim of achieving mass customization of products and services. There is evidence that postponed configuration and shipment, achieved largely through logistics is the most prominent application of postponement at the present time. For sales and services the application of postponement throughout the chain enables the establishment of a different type of customer interaction. Sales can become more interactive and consultative as customers can be involved in the specification of products, as in the SMART case. The resulting situation is one in which sales data have an important input in engineering and product composition ("why make anything you're not surely selling?"). As a result, integration can be cross-functional, cross-company and supported by the exchange of data between players in the chain, as opposed to the more traditional, and nowadays restrictive, form of integration based on ownership. Suppliers are being involved in the engineering of products and the manufacturer aims at specifying the overall product architecture while allowing for a strong input from the supplier at the level of modules and components. The task of logistics is to facilitate the seamless integration of manufacturing (including the operation of manufacturing activities in the logistics channel) and sales (in order to achieve high customer service goals).

For the **control** of virtually integrated supply chains a new set of performance measures may have to be developed[1]. These measures will have to adopt a supply chain perspective (i.e. integrated measures) and focus on the contribution of the various functions and players in the supply chain to overall chain performance. For purchasing, the percentage of added value purchased (over 50 per cent in the case of SMART) and the order-delivery lead time (less than an hour in the SMART case) may be relevant measures. For logistics, lead time (4.5 days in the SMART case), which is very short) and fill rates are likely to be relevant. For marketing and manufacturing, various categories of information about suppliers and customers may be important, especially with respect to their ability to integrate into the overall operation and into the information flow.

Table III attempts to look beyond the data presented in this paper for the challenges facing the management of various functions and companies in the years to come. While there is a challenge to increasingly involve suppliers in operations and innovations, the manufacturer must also try to maintain a lead over suppliers by specifying the overall product architecture, and integrating the flow of information. In that respect the manufacturer begins to operate as a project manager, rather than as an operator. In the logistics channel finished goods inventory can be avoided by storing generic components and by combining them rapidly into customized products. All this is in combination with short lead times and direct distribution to the customer, employing the critical role of logistics.

Fundamental to the supply chain concept of SMART is the development of new customer relations in an increasingly competitive market. Interactive sales are used to develop intimate customer knowledge and relations, while the modular production concept is used to keep customers for a prolonged life cycle (i.e. changing modules during the product's usage). The result is close customer relations in which the customer drives the (entire) supply chain.

Conclusions

This paper suggests there are three central elements within the **virtual** integration **business model** :

- (1) the application of postponement throughout the supply chain;

- (2) extensive outsourcing and subcontracting, leading to

- (3) **control** based on information integration, as opposed to integration based on ownership or the co-ordination of physical flows.

An empirical investigation of factors contributing to the application of postponement has indicated that the (external) application of ICT greatly facilitates customer responsiveness and the application of postponement. Operating characteristics and production and marketing circumstances, however, have to be capable of enabling postponement. The case study of the SMART car, involving a highly innovative supply chain format wherein postponement and outsourcing are extensively applied, demonstrates that virtual integration is actually happening and creating a major impact, not only on the central manufacturer, but also on the suppliers and distributors. A set of challenges for the structuring of the supply chain, involving virtual integration, has been presented for the various (functional) elements of the supply chain. These challenges explicitly recognize that the information flow no longer is a biproduct of the flow of goods but a primary element of the supply chain format. A thorough integration of the flow of goods and information can lead to the creation of new products and services, new marketing approaches and operations. Most fundamental is the role of virtual integration in changing the customer relationship to one involving a high degree of interaction and direct contact given the ability to mass customize products and extensively involve multiple players and functions based on an integrated information flow (including POS data, planning data and market data).

Note

1. In this regard, the CLM recently (1998) initiated a new study on the measurement of logistics activities in the supply chain.

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Caption: Table I; Constructs and items used in the model; Figure 1; Model explaining the application of postponement; Table II; Results of multiple regression analysis; Figure 2; The decreasing role of the manufacturer in operations; Table III; Challenges in **controlling** and structuring virtually integrated supply chains

DESCRIPTORS: Studies; Logistics; Supply chains; Outsourcing; Information sharing
CLASSIFICATION CODES: 9130 (CN=Experimental/Theoretical); 5160 (CN=Transportation)
PRINT MEDIA ID: 14901

Logistics and virtual **integration Postponement, outsourcing and the** flow **of information**
...TEXT: a number of days (postponed manufacturing). Michael Dell, founder of Dell Computers, calls this the **business model** of **virtual** integration (Magretta, 1998); the company is focused on the individual customer and integrates the supply...

... a function dealing with the physical flow of goods. How does one mange, structure and **control** logistics in virtual supply chains? Three elements of the logistics operating structure appear to be...

... and the large number of (outside) companies involved in the physical sphere. The company achieves **control** not through ownership, but rather by mastering the flow of information while focusing its competitive...

...to customers.

This paper aims to study both these elements and their role in the **virtual** integration **business model** . Two methods are used: a survey and a case study. A survey was developed and...

... as contributing to the creation of a virtually integrated supply chain in which integration and **control** is not based on direct ownership but rather on connectivity in the flow of information...at multiple points in the supply chain, in this case involving extensive outsourcing and sub-**contracting** . In the SMART case a high degree of integration is achieved through the joint involvement...of the extensive involvement of suppliers and distributors.

MCC, the OEM in this case, maintains **control** over the supply chain by **controlling** and integrating the flow of information. They inform